Minerals yearbook 1935. Year 1934 1935

Kiessling, O. E.
Washington, D. C.: Bureau of Mines : United States Government Printing Office, 1935

UNITED STATES DEPARTMENT OF THE INTERIOR

HAROLD L. ICKES, Secretary

BUREAU OF MINES

JOHN W. FINCH, Director

MINERALS YEARBOOK

1935

Compiled under the supervision of

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pp 563–598 missing

UNITED STATES

GOVERNMENT PRINTING OFFICE

WASHINGTON : 1935

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FOREWORD

Although the Minerals Yearbook, 1935, represents a specific service to the mineral industry, the volume is also tangible evidence of the useful cooperation that exists between the Federal Government and mining men and expresses some of the objectives of the United States Bureau of Mines as a service organization. In this role the Bureau's primary responsibility is to lay a foundation of fact upon which the mineral industry can build. In carrying out this duty the Bureau's task of service and fact-finding falls roughly into three principal divisions: (1) Technology of the mineral industries, (2) health and safety in mines, and (3) mining economics.

Mining technology.—The business depression has not lessened but has increased the need for a vigorous attack upon the problems of mining technology. The existence of more than adequate supplies of some minerals does not eliminate the urgency of attention to production technique but creates a strong demand for intensive study. Low price levels for metals require cheapening of every step in metal production, and new processes, new uses, and new markets for minerals must be found. Moreover, recently discovered, relatively high-grade mineral deposits in the less industrially developed regions of the globe necessitate accelerated technologic progress in the United States if its industrial competitive position is to be maintained.

Health and safety.—Although much progress has been made during the past decade in mine-safety measures, this is still the most backward major industrial nation in mine-accident prevention. Only Chile exceeds the accident rate in mines of the United States. While the human aspect of the tragedies of mine disasters and their heavy loss of life is the overwhelming motive for an effective mine-safety program, the economic expense of accidents must also be considered, because it is a large factor in costs of producing minerals. The Bureau recognizes the urgent need for accident and health work in mines and the responsibility of the Federal Government for leadership in this field. Neither depression nor prosperity can change the need or the responsibility. The cooperation of States and mineral producers is vital in an aggressive, effective, long-time mine-safety program. It must function continuously, especially in maintaining contacts with mine workers. Hitherto health and safety work has been conducted by the voluntary cooperation of producers with the Government. Mine workers now have begun to realize their responsibility. Their full cooperation is necessary to the achievement of satisfactory results.

Economics and statistics.—Vanishing markets, disappearing profits, excess capacity, huge accumulations of some of the metals, unemployment, and frozen investments call for intensive work in mineral economics. In the investigation of many mineral products, particularly the nonferrous metals, studies must have international scope. Under confidential relations that have been established mineral producers give freely to the Bureau all necessary figures, and these data are merged in general results very useful in economic analyses. Clearly, in view of the urgency of such analyses, all the fundamental work upon which they are based should be strengthened and developed so as to give the economist and the mineral producer a comprehensive picture of mineral resources, output, consumption, distribution, and trade conditions, as well as of regional and international factors affecting the movement and utilization of mineral commodities.

Economic analyses attain widest utility only when they have a specific and useful local application. Each branch of the mining industry needs increased assistance in meeting the varying problems peculiar to individual operating groups or mineral areas.

Appropriations.—The Bureau of Mines has been subject to drastic curtailment of appropriations as part of the general plan of Federal economy during the lean years of the depression. This, of course, has been a serious handicap to adequate performance. In response to numerous appeals from the mining industry urging that the Bureau be given sufficient funds to resume important services that had been discontinued or curtailed Congress increased the Bureau's appropriation for the fiscal year 1935–36. Even with the increase, however, the appropriation for the current year is 26 percent below that for 1929.

Publications.—The cost of preparing and printing the Minerals Yearbook makes a heavy demand on the slender printing funds of the Bureau, but the importance of the volume and the demand for it in the mining industries justify the expenditure. In 1934 more than 7,500 copies were distributed. The Bureau buys copies to distribute free to certain educational institutions and reference libraries, but beyond that it cannot go. The book is obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a low price; the 1,154-page bound volume for 1934 sold for $1.75. The Government Printing Office is in no way connected with the Bureau of Mines, and no money derived from the sale of the book or any other publications comes to the Bureau.

John W. Finch, *Director.*

July 10, 1935.

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INTRODUCTION

The United States Bureau of Mines is the principal Federal agency for collecting, analyzing, and publishing the economic record of the mineral industry. Since this industry includes the mineral fuels—coal, petroleum, and natural gas—as well as metals and nonmetals the task is one of large proportions and of great concern to the economic welfare of the Nation. In carrying out its duty of fact-finding and of disseminating information the Bureau has developed three well-defined groups of publications: (1) Periodic or preliminary reports, usually mimeographed, that release current statistics with maximum speed, (2) economic studies that deal exhaustively with relatively limited fields or subjects, and (3) Minerals Yearbook that presents the current annual record of the various mineral industries against a background adequate for perspective in the interpretation of current trends.

The need for comprehensive current statistics and the development of such services following the World War were set forth in the introduction to Minerals Yearbook, 1934; these services represent a superstructure reinforced by the Minerals Yearbook record, which extends from 1866 to the present, as explained in the introduction to the 1932–33 volume.

Both the Minerals Yearbook and the periodic statistical services of the Bureau are supplemented by a third class of publications which have become an important outlet for information beginning with the institution of the Economics Branch in the Bureau in 1925, first under the Department of Commerce and since April 24, 1934, under the Department of the Interior. The general characteristics of this type of publication are specialization of treatment or purpose, consideration of a limited field or subject, and attention to development of extensive background where necessary. Studies of this kind are published as: (1) Economic papers, (2) information circulars, and (3) reports of investigations.

The series of economic papers was initiated by the publication of Summarized Data of Copper Production (Economic Paper 1) in 1928. This paper gives the annual output of copper for each copper-producing country in the world from 1801 through 1927, and the historical record of output for the United States is shown in detail by States. The text discussion emphasizes the many factors that affected copper production over the period studied, such as discovery of large deposits, advancement of technology, and the development of new uses. Other economic papers cover production records for various minerals, give data on consumption, or appraise technical and economic changes taking place in a specific branch of mining. Economic Paper 11, The Economics of Strip-Coal Mining, for example, discusses the effect of technologic advances in coal-stripping upon the status of the coal industry.

Information circulars are utilized principally for publishing material requiring frequent revision or to throw light upon some questions of immediate interest. A recent example of the latter is Information Circular 6773, Silver Yield from Copper Ores and the Effects of 64.64-Cent Silver on the Value of Copper Ores Produced in the United States. This report presents statistical data concerning the relation of the silver price to the value of copper ores mined in the United States and concludes that the new silver price is not expected to change greatly the sources of copper production or to increase materially the output of byproduct silver from copper ores. Another type of information circular is that represented by Consumption of Tin in the United States, 1925 (Information Circular 6019), which began a series of tin-consumption studies; the 1925 report later was revised three times on the basis of data for 1927, 1928, and 1930. Each revision was occasioned by a new canvass of domestic tin consumers, which both provided new figures for publication and indicated much miscellaneous material helpful for the study of tin consumption in the United States.

In addition to economic papers and information circulars, economic and statistical material has been published as reports of investigations. Recent Trends in Man-Hour Production in Iron-Ore Mines (Report of Investigations 3266), for example, sets forth the record of employment and man-hour output in the iron industry from 1923 through 1932. In general, the findings of publications in this class are regarded as of permanent value, but the narrowness of the subject or the brevity of the discussion does not seem to justify printing as an economic paper.

What has been noted regarding the use of reports of investigations and information circulars as devices for releasing economic and statistical information does not, of course, apply to the use of these publication vehicles by other branches of the Bureau. Beside official publications, moreover, technical and trade journals frequently are utilized by members of the Economics Branch to bring the summarized results of original findings before an interested audience.

Thus the Minerals Yearbook is complemented by quickly published mimeographed statistics in the form of periodic current services or preliminary mineral market summaries, as well as by the detailed studies presented in economic papers, information circulars, and reports of investigations. Through these outlets the Economics Branch has made available the large amount of material it gathers. There is no desire, however, to crystallize either the form in which information is released or the scope of the studies, for the changing interests of the mineral industry require frequent redirection of research effort in mining economics and statistics if the Bureau is to render the greatest possible service. The development of codes for many branches of mining under the National Recovery Administration, for example, brought into being a series of economic considerations that are recorded as far as advisable in appropriate chapters of the Minerals Yearbook. Likewise, recommendations of the President's Planning Committee for Mineral Policy that refer to specific minerals are noted in the commodity discussions.

The importance of the report of the Planning Committee for Mineral Policy, however, extends far beyond any consideration of individual commodities, as is illustrated by the following statement regarding the origin of the Committee's work:[1]

The difficulties of the mineral industries were brought to a crisis by the great depression. Metal mining—a handmaid of the capital goods industries—was prostrated. The oil industry struggled with a glut intensified by the phenomenal east Texas field. Coal mining saw the near collapse of the machinery of collective bargaining, and wages in some fields sank to starvation levels. The plight of the mine workers became among the most tragic of any section of our people.

A further effect of the depression was to intensify the existing waste of the underground resources. While great advances in mineral technology had occurred since the Conservation Commission of 1908 but little progress had been made in checking the resource losses associated with destructive competition and overdevelopment. With the coming of the depression, the loss increased. Some coal operators gave up the attempt to recover pillars. Waste of natural gas and overproduction of oil became more serious. In metal mining the collapse of prices forced many owners to "pick the eyes out" of their reserves and to abandon large tonnages of low-grade ore. Concern with the hardships of the mine workers and with the financial losses of owners was now reenforced by concern over the growing waste of the resources.

Acting on a suggestion from the Science Advisory Board, President Roosevelt in April 1934 appointed a Planning Committee for Mineral Policy. The committee was instructed to consider such questions as the estimating of future consumption, the curtailment of excessive production, the coordination of emergency appropriations in the mineral field, the relationship between Federal and State policy, the treatment of mineral resources on the public domain, the conservation of resources, and the effect of mineral tariffs—in short to undertake a general study of the mineral resources of the United States with a view to the establishment of a national mineral policy.

* * * * * * *

Upon the creation of the National Resources Board, the Committee was also made the Mineral Section of the Technical Committee of the Board in order to care for the expenses of the Planning Committee for Mineral Policy and to assist the Board in its studies.

The Committee's extensive report includes many recommendations and suggestions that will be of interest to producers and to observers of the mineral industries,[2] but which are largely outside the Bureau's field of activity. The report points out, however, the urgent need for continuing, improving, and strengthening the present fact-finding statistical and economic services on minerals.

In addition to supervising the preparation of nonmetallic statistics and drafting the chapters on Cement, Sand and Gravel, and Review of the Mineral Industry, H. H. Hughes served as editorial associate; M. B. Clark supervised statistical presentation and Max Abel the preparation of graphic material. J. W. Furness, R. J. Lund, and M. E. Winslow supplied many helpful suggestions for improvement of the individual chapters. Unless otherwise indicated, data on mineral production in foreign countries were compiled by L. M. Jones, assisted by M. T. Latus, and tables of exports and imports were compiled from the records of the Bureau of Foreign and Domestic Commerce by Claude Galiher.

Special acknowledgments are also due to the State officials who have assisted in the collection of returns and who supplied information in their files. Help has been received from Walter B. Jones, State geologist, University, Ala.; Walter W. Bradley, State mineralogist,

[1] National Resources Board, A Report on National Planning and Public Works in Relation to Natural Resources and Including Land Use and Water Resources with Findings and Recommendations: Washington, 1934, pp. 31–32.

[2] National Resources Board, work cited: Part IV, Report of the Planning Committee for Mineral Policy, 1935, pp. 389–449.

San Francisco, Calif.; Herman Gunter, assistant supervisor of geological department, State board of conservation, Tallahassee, Fla.; Richard W. Smith, State geologist, Atlanta, Ga.; M. M. Leighton, chief of State geological survey division, and Walter H. Voskuil, mineral economist, Urbana, Ill.; A. C. Trowbridge, director, Iowa geological survey, Iowa City, Iowa; Raymond C. Moore, State geologist, Lawrence, Kans.; Edward B. Mathews, State geologist, Baltimore, Md.; R. A. Smith, State geologist, Lansing, Mich.; H. A. Buehler, State geologist, and H. S. McQueen, assistant State geologist, Rolla, Mo.; H. B. Kummel, State geologist, and Meredith E. Johnson, assistant State geologist, Trenton, N. J.; Charles C. Adams, director of New York State Museum, D. H. Newland, State geologist, and C. A. Hartnagel, assistant State geologist, Albany, N. Y.; H. J. Bryson, State geologist, Chapel Hill, N. C.; E. P. Rothrock, State geologist, Vermillion, S. Dak.; E. H. Sellards, director of bureau of economic geology, Austin, Tex.; Arthur Bevan, State geologist, University, Va.; Harold E. Culver, supervisor of division of geology, department of conservation and development, Pullman, Wash.; and E. F. Bean, State geologist, Madison, Wis.

O. E. Kiessling.

July 5, 1935.

PART I. SURVEY OF THE MINERAL INDUSTRIES

REVIEW OF THE MINERAL INDUSTRY

By H. H. HUGHES AND F. J. McCARTHY, Jr.

SUMMARY OUTLINE

The mineral production of the United States in 1934, including metals, nonmetals, and fuels, was valued at $3,350,000,000, an

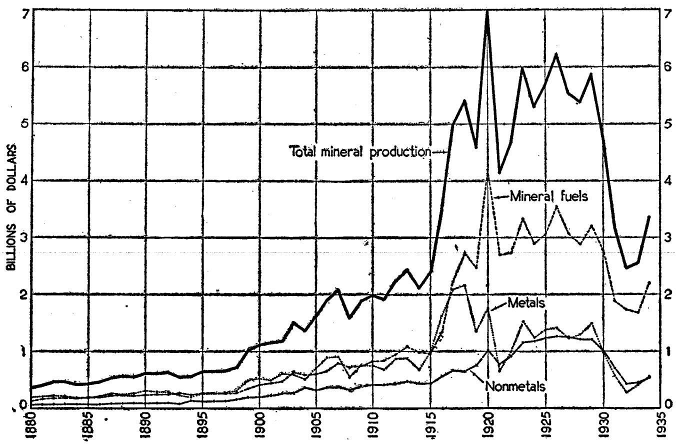

FIGURE 1.—Mineral production of the United States, 1880–1934.

increase of 31 percent from $2,555,100,000 in 1933. This advance in total value reflected not only increased output but also higher unit prices, which resulted in part from provisions of codes of fair competition under which virtually all branches of the mineral industry operated to some extent during 1934. Production of virtually all major mineral commodities increased in 1934; outstanding examples were coal, gold, silver, natural gas, cement, and crushed stone. Prices likewise increased, especially for silver, gold, pig iron, copper, petroleum, bituminous coal, and cement.

Historical summary.—The total value of minerals produced in the United States exceeded 1 billion dollars for the first time in 1899.

By the beginning of the World War in 1914 the value of output had approximately doubled, and during and immediately following the war it rose sharply, reaching an all-time high of nearly 7 billion dollars in 1920. The peak in 1920 reflected extremely high prices during the year rather than an actual peak in the quantity of minerals produced. The value was relatively high from 1925 to 1929, exceeding 6 billion dollars in 1926, but after 1929 it dropped during the depression to a low of about 2½ billions in 1932, the lowest total since 1915. Moderate gains were made in both 1933 and 1934, bringing the total to more than 3 billions. (See fig. 1.)

The general trend in value of mineral-fuels production since 1880 has followed closely that of all minerals. Production of metals spurted during the war, but the value dropped in 1932 to the lowest level since 1897. Production of nonmetallic minerals benefited by the post-war building boom but dropped sharply from 1929 to 1932.

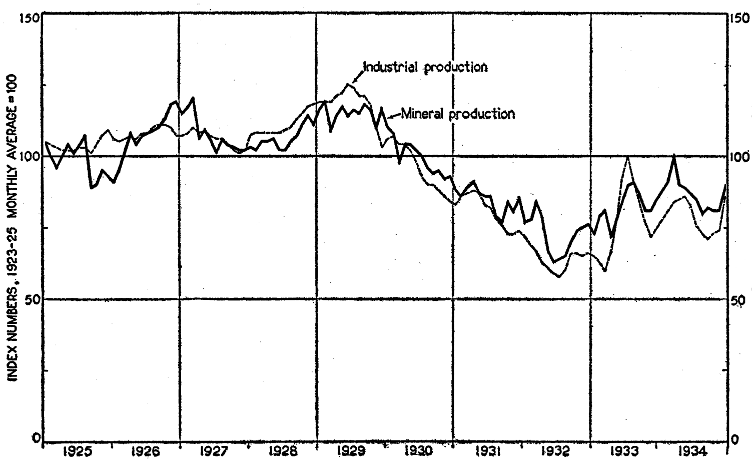

FIGURE 2.—Mineral production in the United States compared with total industrial production, 1925–34. Data are from the Federal Reserve Board.

Comparison with other industries.—Although the trend of mineral output was sharply downward during the depression the decline was not as pronounced as that of all industrial production. (See fig. 2.) Indexes compiled by the Federal Reserve Board with the 1923–25 average as 100 show that the mineral industry was relatively more active from 1930 to 1934 than business in general. The annual index of total industrial production dropped from 96 in 1930 to 64 in 1932 and recovered to 79 in 1934, whereas the index of mineral production dropped only to 73 in 1932 and rose to 87 in 1934.

Comparison between mineral production and manufacturing output has not been shown graphically because the trend of the index of manufactures virtually coincides with the index of total industrial production. The annual index of manufactures was 95 in 1930, slumped to 63 in 1932, and rose to 78 in 1934.

The stability of markets for agricultural products is shown by the index of quantities marketed compiled by the Bureau of Foreign and Domestic Commerce. This index dropped only to 84 in 1932 compared with 73 for mineral production but after rising to 88 in

1933 dropped again to 82 in 1934, whereas the index of mineral production advanced to 87 in 1934. (See fig. 3.)

The construction industry boomed from 1925 to 1929 and then experienced what probably was the sharpest recession in any large

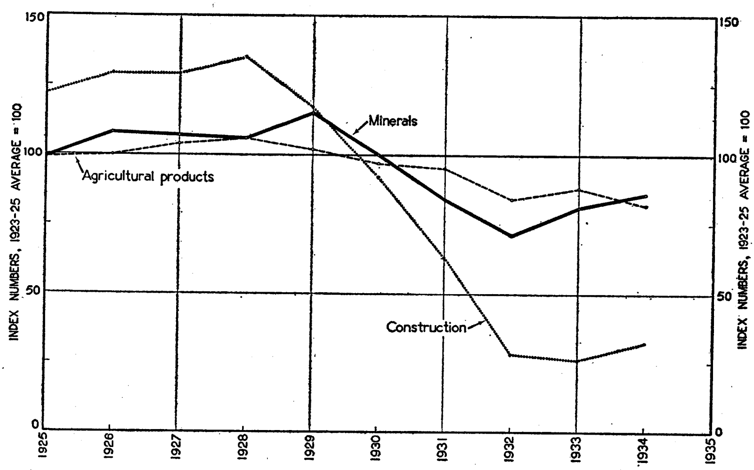

FIGURE 3.—Mineral production in the United States compared with construction contracts awarded and agricultural products marketed, 1925–34. Indexes for minerals and construction were compiled by the Federal Reserve Board and the index for agricultural products by the Bureau of Foreign and Domestic Commerce.

industry during the depression period. Indexes compiled by the Federal Reserve Board from statistics on value of construction contract awards collected by the F. W. Dodge Corporation showed a rise to 135 in 1928, followed by a slump to 26 in 1933 with a moderate upturn to 32 in 1934.

Production and index numbers of the principal mineral commodities of the United States, 1931–34

Commodity	Production				Index numbers (1925–29 average=100)			
	1931	1932	1933	1934	1931	1932	1933	1934
Metals:								
Copper ... short tons	521,000	272,000	225,000	244,000	58	30	25	27
Lead ... do	390,000	255,000	260,000	300,000	59	39	39	45
Zinc ... do	292,000	207,000	306,000	355,000	49	35	52	60
Gold ... ounces	2,396,000	2,449,000	2,556,000	[1] 3,075,000	105	108	112	[1] 135
Silver ... do	30,932,000	23,981,000	23,003,000	[1] 31,400,000	50	39	37	[1] 51
Pig iron ... long tons	17,813,000	8,518,000	14,353,000	15,633,000	47	22	38	41
Aluminum ... short tons	89,000	52,000	43,000	37,000	101	59	49	42
Total metals, weighted average					54	31	39	[1] 43
Fuels:								
Petroleum ... barrels	851,000,000	785,000,000	906,000,000	[1] 909,000,000	98	90	104	[1] 105
Natural gas ... M cubic feet	1,686,000,000	1,556,000,000	1,555,000,000	[1] 1,950,000,000	113	105	105	[1] 131
Bituminous coal ... short tons	328,089,000,000	309,710,000,000	333,631,000,000	[1] 358,395,000,000	72	59	63	[1] 68
Anthracite ... do	59,647,000,000	49,855,000,000	49,541,000,000	[1] 57,385,000,000	79	66	66	[1] 76
Total fuels, weighted average					88	78	85	[1] 91
Nonmetals:								
Sulphur ... long tons	2,129,000	890,000	1,406,000	1,421,000	109	46	72	73
Portland cement ... barrels	125,000,000	77,000,000	63,000,000	[1] 77,700,000	74	46	37	[1] 46
Lime ... short tons	2,708,000	1,960,000	2,269,000	[1] 2,407,000	61	44	51	[1] 54
Sand and gravel ... do	153,479,000	120,000,000	107,800,000	[1] 113,000,000	78	61	55	[1] 57
Building stone ... cubic feet	21,461,000	16,624,000	11,512,000	[1] 9,000,000	66	51	36	[1] 28
Slate ... short tons	368,000	284,000	260,000	233,000	53	41	38	34
Gypsum ... do	2,559,000	1,416,000	1,335,000	1,536,000	48	26	25	29
Crushed stone ... do	72,624,000	52,000,000	45,000,000	[1] 57,600,000	83	59	51	[1] 66
Salt ... do	7,358,000	6,408,000	7,605,000	7,612,000	94	82	98	99
Total nonmetals, weighted average					76	51	46	[1] 52
Total minerals, weighted average					78	62	68	[1] 74

[1] Subject to revision.

Domestic production.—Mineral production during 1934 continued the upward trend begun in 1933. The index of quantity production, based on the 1925–29 average as 100, reached 74 in 1934 after dropping to a low of 62 in 1932. All groups of minerals, as well as virtually all individual commodities, shared in the rise during 1934. Fuel production was relatively steady during the depression and was the principal factor in maintaining the relatively high level of the index for all minerals, as metals, particularly, and nonmetals dropped sharply.

The index for fuel production was 91 in 1934 (1925–29 average=100) after reaching a low of only 78 in 1932. Natural-gas and petroleum production were the principal stabilizing factors in the fuel group. Natural-gas production remained above the 5-year predepression average and in 1934 was 31 percent above that level. Petroleum dropped only to 90 in 1932 and rose to 105 in 1934. Bituminous coal and anthracite had less satisfactory indexes—59 and 66, respectively, in 1932 compared with 68 and 76, respectively, in 1934.

The curve of metal production during the past 5 years has been the lowest of the mineral groups. After reaching a low of 31 in 1932, however, the index rose to 43 in 1934. Gold has been the one exception to the relatively low production record of the metals; during the past 5 years the output of this metal remained above the 1925–29 average continuously, and in 1934 the index was 135. Pig iron reached the lowest point of any commodity, dropping to 22 in 1932 but rising to 41 in 1934. Copper, with a production index of only 25 in 1933, reached its low point a year later than most minerals, but the index increased slightly to 27 in 1934. Aluminum was the only principal metal that did not show a rise during 1934. Silver production showed the largest relative rise, increasing from 23,003,000 ounces in 1933 to 31,400,000 ounces in 1934, or a rise in the index from 37 to 51.

The production index for nonmetals, which remained under the all-minerals index during the past few years, did not reach its low point (46) until 1933, and then increased to 52 in 1934. Salt was the only nonmetal that showed a semblance of stability during the depression. The production of each of the other nonmetals in at least 1 year during the past 5 dropped either close to or considerably below half of its 1925–29 average annual production. In 1934, however, production of every principal nonmetal except building stone and slate increased over 1933.

Prices.—Prices of mineral commodities rose sharply in 1934, and for the first time in the last 10 years the minerals price index was higher than the index for wholesale prices of all commodities, based on 1926 as 100. Mineral prices during the last decade in general have followed the trend of all wholesale prices, although they tended to be somewhat lower until 1934. The sharp increase in mineral prices in 1934 probably was due not only to the price stabilizing features of the codes of fair competition but also to the general upward trend of all prices. The total minerals index, however, did not start upward until 1934, whereas the wholesale price index began to rise a year earlier. This was due almost entirely to the depressing influence of fuel prices during 1933, particularly that of petroleum which dropped from an average of 87 cents per barrel in 1932 to 67 cents per barrel in 1933. All groups of minerals, however, including fuels, as well as almost every important mineral commodity, showed a definite upward trend during 1934.

Wholesale price index of all commodities compared with price indexes of total minerals, metals, fuels, and nonmetals, 1925–34

[1926=100]

	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934 [1]
Metals	103	100	92	89	96	85	73	64	67	79
Fuels	94	100	83	78	78	76	60	61	56	72
Nonmetals	101	100	96	93	91	88	79	73	81	88
Total minerals	97	100	87	83	85	79	66	64	62	76
Wholesale price of all commodities [2]	104	100	95	98	95	86	73	65	66	75

[1] Subject to revision. [2] From U. S. Bureau of Labor Statistics.

The metals price index, which reached 79 in 1934 and was above the all-minerals and the general wholesale price indexes, has followed

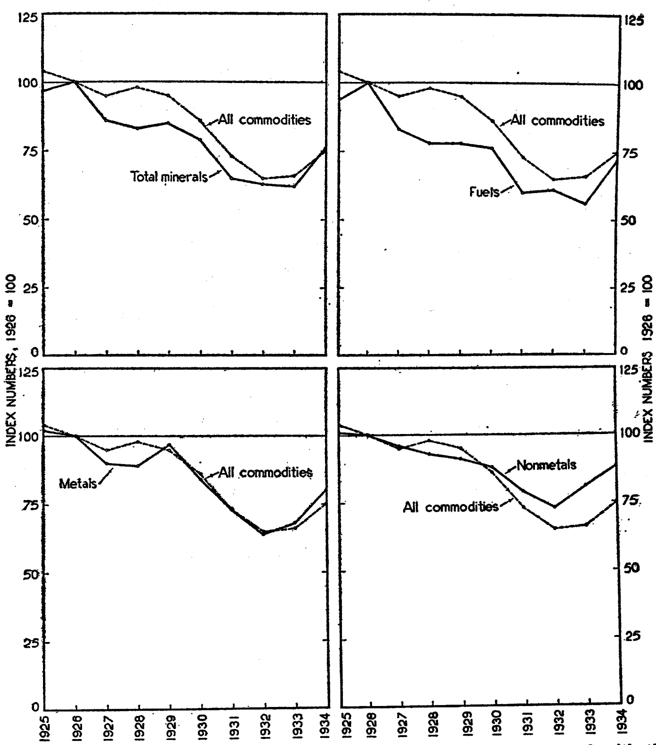

FIGURE 4.—Trends in prices of all minerals, metals, fuels, and nonmetals compared with the wholesale price index of all commodities, 1925–34. Wholesale price index from U. S. Bureau of Labor Statistics.

closely the trend of wholesale prices since 1929, although the rise in metal prices since 1932 has been more rapid than wholesale prices. Gold has been the only important metal, in fact, the only important mineral, except sulphur, that has not shown a decrease in price during the last 10 years; had it not been for the stability in the price of gold the index of all metal prices would have been even lower during the depression. Since 1932, however, all the principal metals except aluminum have shown an upward trend. Copper increased from an average of 6.3 cents per pound in 1932 to an average of 8.0 cents in 1934; lead from 3.0 to 3.7 cents; zinc from 3.0 to 4.3 cents; gold from $20.67 an ounce to $34.95; pig iron from $14.80 a long ton to $16.93, and silver, which made the largest relative increase, jumped from 28.2 cents an ounce to 64.65 cents.

The fuel price index of 72 (1926=100) in 1934 remained below both the index of all minerals and the wholesale price index. Improvement during 1934 was rapid, however, compared with 1933, when the fuel index was 56, the lowest point reached during the depression for any of the 3 groups of minerals. The drop in the price for petroleum in 1933 was the most important factor in the general decline of fuel prices, although the bituminous coal price was also comparatively low. Anthracite and natural gas maintained a higher degree of stability.

Prices of nonmetals on the whole held up better during the depression than any of the other mineral groups, and in 1934 the price index stood at 88, or 12 points above all minerals and 13 points above wholesale prices. Prices for many of the nonmetals were relatively steady during the last few years, particularly for sulphur, which has been quoted at the same price—$18 per ton—since 1926. Many of the building materials also held up fairly well, such as sand and gravel, building stone, crushed stone, and gypsum. The low point for nonmetals was reached in 1932, but since then the price curve has been sharply upward. Cement probably was the most important factor in this rise, as the average factory value jumped from $1.01 per barrel in 1932 to $1.52 in 1934.

Prices and index numbers of the principal mineral commodities of the United States, 1931–34

Commodity	Average prices				Index numbers (1925–29 average=100)			
	1931	1932	1933	1934	1931	1932	1933	1934
Metals:								
Copper [1] ....cents per pound..	9.1	6.3	6.4	8.0	61	43	43	54
Lead [1] ....do....	3.7	3.0	3.7	3.7	53	43	53	53
Zinc [1] ....do....	3.8	3.0	4.2	4.3	56	44	62	63
Gold [2] ....dollars per ounce..	20.67	20.67	25.56	34.95	100	100	124	169
Silver [3] ....cents per ounce..	29.0	28.2	35.0	64.65	48	47	58	107
Pig iron [1] ....dollars per long ton..	16.01	14.80	14.86	16.93	86	80	80	91
Aluminum [1] ....cents per pound..	21.0	19.5	19.0	19.0	87	81	79	79
Total metals, weighted average..........					76	67	70	82
Fuels:								
Petroleum [4] ....dollars per barrel..	0.65	0.87	0.67	[5] 0.99	45	60	47	[5] 69
Natural gas [6] ..cents per M cubic feet..	23.3	24.7	23.7	[5] 23.5	104	111	106	[5] 105
Bituminous coal [7] .dollars per short ton..	1.54	1.31	1.34	[5] 1.82	79	67	69	[5] 93
Anthracite [7] ....do....	4.97	4.46	4.17	[5] 4.24	93	84	78	[5] 80
Total fuels, weighted average..........					70	71	65	[5] 83
Nonmetals:								
Sulphur [8] ....dollars per long ton..	18.00	18.00	18.00	18.00	102	102	102	102
Portland cement [9] ..dollars per barrel..	1.11	1.01	1.33	[5] 1.52	68	62	82	[5] 93
Lime [10] ....dollars per short ton..	6.90	6.28	6.28	[5] 7.06	80	73	73	[5] 82
Sand and gravel [10] ....do....	.56	.48	.49	[5] .57	93	80	82	[5] 95
Building stone [10] .dollars per cubic foot..	1.30	1.21	1.33	[5] .95	104	97	106	[5] 76
Slate [10] ....dollars per square foot..	8.52	7.43	6.32	7.54	79	69	59	70
Gypsum [11] ....dollars per short ton..	2.02	2.09	1.92	1.89	86	89	82	81
Crushed stone [10] ....do....	.97	.90	.86	[5] .95	93	87	83	[5] 91
Salt [10] ....do....	2.93	3.11	2.93	3.00	88	93	88	90
Total nonmetals, weighted average...					82	76	84	[5] 91
Total minerals, weighted average..........					73	71	69	[5] 84

[1] The prices for copper, lead, zinc, pig iron, and aluminum are weighted averages, for each year, of all grades of primary metal sold by producers.

[2] The price for gold in 1931–32 is $20.671835 per ounce, the Treasury legal coinage value for fine gold from Jan. 18, 1835, to Jan. 31, 1934; the price in 1933 is $25.56 and in 1934, $34.95 per ounce, the average weighted yearly U. S. Government prices.

[3] The price for silver in 1931–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+per ounce.

[4] Bureau of Mines average value at the well.

[5] Subject to revision.

[6] Bureau of Mines average value at points of consumption.

[7] Bureau of Mines average value at the mine.

[8] Average quoted price, f. o. b. mine.

[9] Bureau of Mines average factory value.

[10] Bureau of Mines average value at plant or point of shipment.

[11] Bureau of Mines average value of crude, at point of shipment.

Prices in 1934 increased at a faster rate and continued to hold a better position relatively than production according to index numbers calculated from the 1925–29 annual average as 100. Early in the depression prices of minerals in general fell more rapidly than production. They were more stable in 1932 but production continued downward, and since then prices have held better than production. The value index, of course, has remained below both prices and production, and since 1933 has moved upward.

Prices of metals, which fell considerably during the past 5 years, have been relatively higher than production. The metals price index dropped only to 67 in 1932, whereas the production index touched 31 for that year. Both production and prices of metals, however, have improved considerably in the last 2 years, although prices are still relatively more stable than production; the production index in 1934 reached only 43, whereas the index for prices rose to 82.

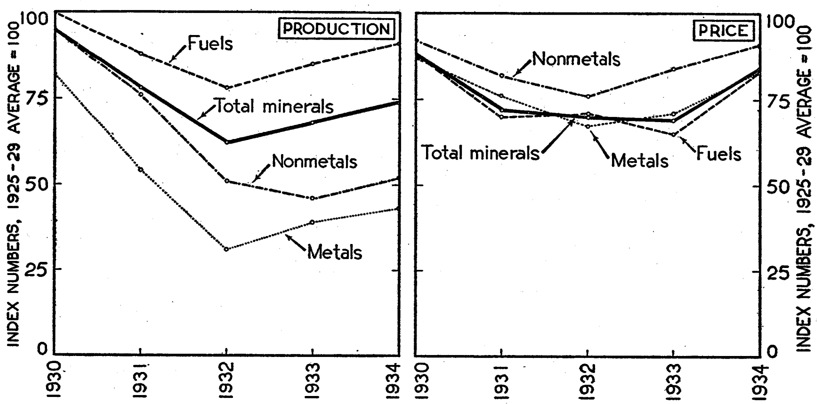

FIGURE 5.—Trends in production and prices of all minerals, metals, fuels, and nonmetals in the United States, 1930–34.

The value index, which was lower than the other indexes during the past 5 years, continued the upward trend started in 1933.

Comparison of trends of quantity, price, and total value of mineral production in the United States, 1930–34

[1925–29 average=100]

Year	Metals			Fuels			Nonmetals			Total minerals		
	Quantity	Price	Total value	Quantity	Price	Total value	Quantity	Price	Total value	Quantity	Price	Total value
1925–29 (average)	100	100	100	100	100	100	100	100	100	100	100	100
1930	82	88	73	100	88	88	95	92	82	95	88	83
1931	54	76	42	88	70	60	76	82	57	78	73	55
1932	31	67	21	78	71	55	51	76	35	62	71	44
1933	39	70	30	85	65	53	46	84	37	68	69	46
1934 [1]	43	82	40	91	83	71	52	91	43	74	84	60

[1] Subject to revision.

As contrasted with the metals, the production of fuels has been more stable than prices during the past 5 years, and in 1934 production remained relatively higher than prices. The lowest point to which the fuel production index dropped was 78 in 1932, whereas the price index for fuels fell to 65 in 1933. Fuel prices, however, in 1934 rose at a much faster rate than production, and the index touched 83 although the production index was even higher (91). The value index for fuels continued steadily downward from 1930 to 1933, inclusive, but it changed its trend in 1934 owing to the sharp rise in prices.

Like the metals, prices of nonmetals were much more stable during the depression than production and since 1931 have continued to remain relatively higher than production. The index of nonmetals prices dropped only to 76 in 1932, but the index of production was 51 and declined in 1933 to 46. Prices of nonmetals in the past 2 years have risen sharply, and the index reached 91 in 1934, virtually the same level as in 1930. Production, on the other hand, showed only a moderate increase—from 46 in 1933 to 52 in 1934—virtually the same level as in 1932. The value index for nonmetals, of course, has continued below the price and production indexes, and after a sharp drop from 1930 to 1932, inclusive, the trend has been upward through 1933 and 1934.

Employment and pay rolls.—Economists [1] of the Brookings Institution computed the total number of persons engaged in the extraction of minerals in 1929 as 1,113,000. This figure covered wage earners, proprietors, and salaried officials and was the sum of the number on the pay rolls during the maximum month for each industry as reported by the Census of Mines and Quarries, United States Bureau of the Census; data on oil-well and gas-well employees were taken from the General Report on Occupations. In addition 254,000 persons were employed in associated industries, such as petroleum refining, smelting, and manufacture of coke, cement, and lime, which trade usage commonly includes with the mineral industry. Total employment in all mineral industries, therefore, was about 1,367,000 persons.

Complete data on employment since 1929 are not available, but the Bureau of Labor Statistics maintains indexes to show trends of employment and pay rolls in several branches of the mining industry. These data indicate that both employment and pay rolls in bituminous-coal and anthracite mining and petroleum production held up well from 1929 to 1934 compared with manufacturing industries, but metalliferous and quarrying and nonmetallic mining dropped sharply. (See fig. 6.)

In terms of 1929 as 100 the index of employment in bituminous-coal mining stood at 77.2 in 1934; anthracite, 59.6; petroleum, 77.7; metalliferous, 41.6; and quarrying and nonmetallic, 48.9. No general index for mining is available, but an approximate weighting of the available figures gives an index of about 69 for 1934. This index applied to the 1929 total indicates that the mineral industries in 1934 employed about 950,000 persons.

Data collected by the Bureau of Mines on actual number of men employed during the year in bituminous-coal and anthracite mining reveal a higher level of employment in 1934 than that shown by the trend of Bureau of Labor Statistics indexes. According to preliminary figures about 450,000 men were employed in bituminous-coal mining in 1934 and 106,000 in anthracite mining, declines of 11 and 30 percent, respectively, compared with 1929. These figures indicate that the total number of men employed in mining industries in 1934

[1] Nourse, E. G., and associates, America's Capacity to Produce: Brookings Inst., 1934, p. 147.

may have reached 1,100,000. The apparent discrepancy between trends shown by figures of the Bureau of Labor Statistics and those collected by the Bureau of Mines reflects a difference in methods of

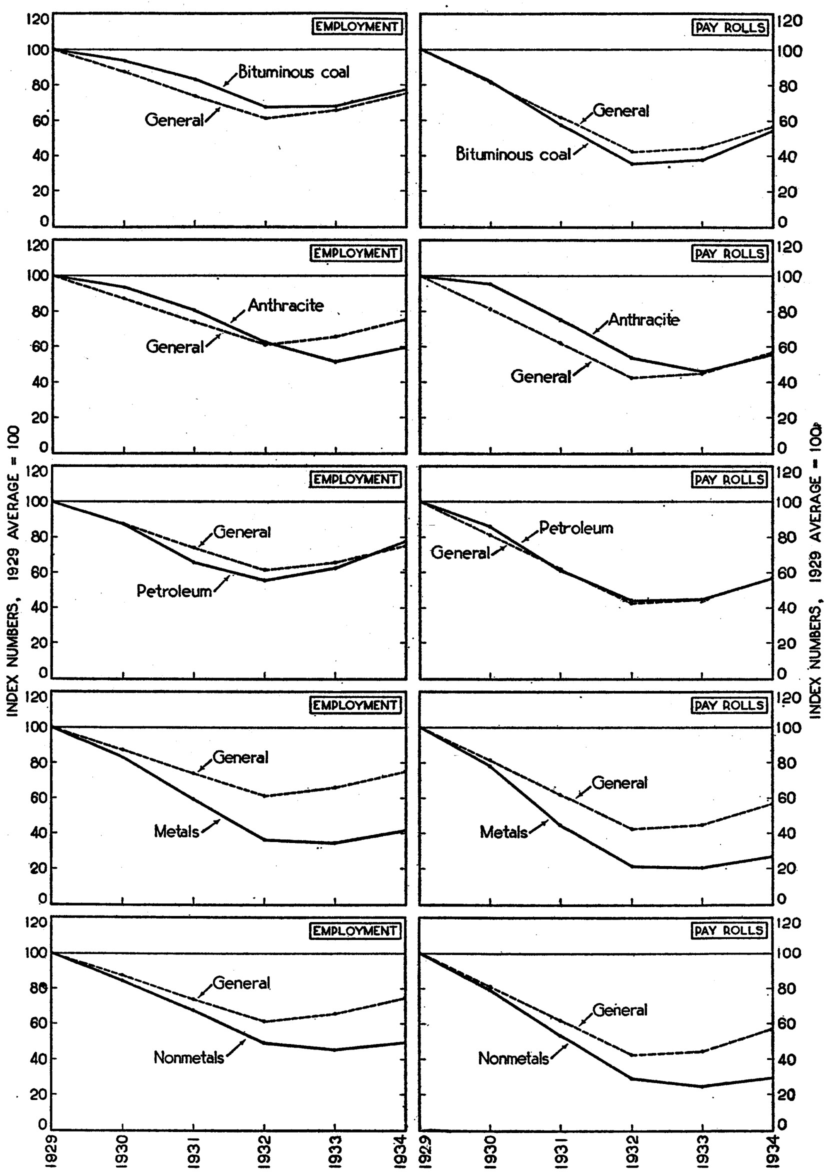

FIGURE 6.—Trends in employment and pay rolls in bituminous-coal, anthracite, metalliferous, and quarry and nonmetallic mining, and petroleum production compared with general indexes of employment and pay rolls in manufacturing industries, 1929-34. All data are from U. S. Bureau of Labor Statistics; the general indexes have been recalculated with 1929 as 100.

statistical collection. The annual indexes of the Bureau of Labor Statistics are averages of monthly data for each industry, whereas the Bureau of Mines figures represent the actual number of men employed for any length of time during the year.

World production.—Mineral production of the world during 1934 continued the upward trend, both in quantity and value, which started from the low point of 1932. Virtually every principal mineral commodity shared in the general rise, in fact, recovery in both quantity and value of mineral production has been relatively greater in the rest of the world than in the United States.

Nickel, gold, and petroleum have shown the largest gains in quantity of production over the predepression 5-year average. The large gain in nickel production, which in 1934 amounted to 157 percent of the 1925–29 average, was due largely to the increased demand for nickel by European steel producers. The trend of gold production has been continuously upward during recent years, and in 1934 the index reached 139. The greater purchasing power of virtually all currencies during the depression, as well as the increase in the actual price of gold in some countries during recent years, probably have been the most important factors in expansion of gold production. World production of petroleum has likewise continued to remain above the 1925–29 average, and in 1934 the index number stood at 120. The world production for each of the important nonferrous metals continued the upward trend started in 1933, and the index for the entire group in 1934 reached 82 compared with 63 in 1932, the low point of the depression period. Production of coal and lignite has been relatively stable during the depression and in 1934 stood at 88 percent of the 1925–29 average, after reaching a low of 78 in 1932. Production of pig iron dropped lower during the past 5 years than most other principal mineral commodities, and the index of world production was only 46 in 1932 but a substantial gain in tonnage during 1933 and 1934 raised it to 71 in 1934. World production of silver reached its low point (63) in 1933, a year later than most minerals; since then the trend has been upward, and in 1934 the index stood at 71.

World production of important metals and fuels, 1925–34

Year	Copper, lead, zinc, aluminum, tin, and nickel		Pig iron		Gold	
	Short tons	Index numbers [1]	Short tons	Index numbers [1]	Ounces	Index numbers [1]
1925–29 (average)	5,536,000	100	94,784,000	100	19,401,000	100
1930	5,688,000	103	88,381,000	93	20,836,000	107
1931	4,582,000	83	61,442,000	65	22,209,000	114
1932	3,462,000	63	43,682,000	46	24,151,000	124
1933	3,876,000	70	54,224,000	57	24,962,000	129
1934 [2]	4,561,000	82	67,295,000	71	27,000,000	139
Year	**Silver**		**Coal and lignite**		**Petroleum**	
	Ounces	Index numbers [1]	Short tons	Index numbers [1]	Barrels	Index numbers [1]
1925–29 (average)	254,377,000	100	1,596,000,000	100	1,248,000,000	100
1930	248,708,000	98	1,559,000,000	98	1,412,000,000	113
1931	195,920,000	77	1,387,000,000	87	1,373,000,000	110
1932	164,893,000	65	1,241,000,000	78	1,310,000,000	105
1933	160,987,000	63	1,292,000,000	81	1,443,000,000	116
1934 [2]	180,000,000	71	1,397,000,000	88	1,500,000,000	120

[1] 1925–29 average=100. [2] Subject to revision.

The quantity and value of world mineral production, exclusive of the United States, did not show as severe a decline during the depression as that registered by the United States; likewise mineral production in the rest of the world has been relatively higher than in this country. It has been estimated that the total value of production of all minerals in the rest of the world in 1932 amounted to about $4,000,000,000 but increased to about $7,400,000,000 in 1934, a rise in the index from 48 to 89. The value of the United States production, on the other hand, amounted to $2,461,000,000 in 1932 and

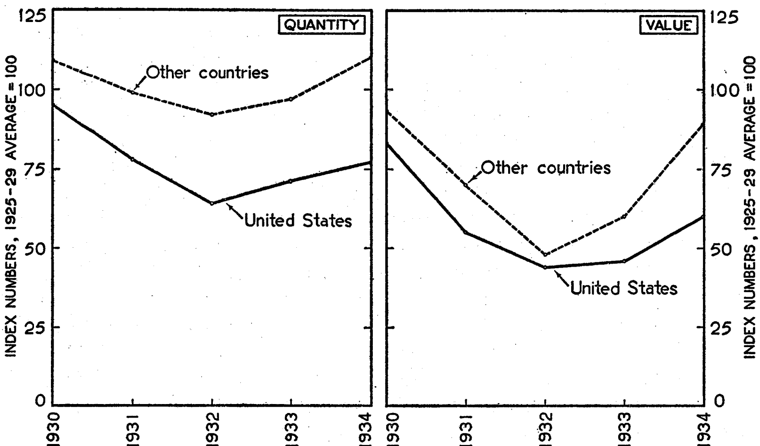

FIGURE 7.—Trends in quantity and value of mineral production in the United States compared with other countries of the world, 1930–34.

increased to about $3,350,000,000 in 1934, a rise in the index from 44 in 1932 to only 60 in 1934.

Value of mineral production in the United States and the world, 1925–34

[Value in billions of dollars. Index numbers based on 1925–29 average=100]

Year	United States		Other countries		World total	
	Value	Index number	Value	Index number	Value	Index number
1925–29 (average)	5.7	100	8.3	100	14.0	100
1930	4.8	83	7.7	93	12.5	89
1931	3.2	55	5.8	70	9.0	64
1932	2.5	44	4.0	48	6.5	46
1933	2.6	46	5.0	60	7.6	54
1934 [1]	3.4	60	7.4	89	10.8	77

[1] Subject to revision.

The index of the quantity of metals and fuels produced in all other countries was 110 in 1934 after declining only to 92 in 1932. In the United States the comparable index reached 77 in 1934 after dropping to 64 in 1932. The production of fuels both in the United States and abroad was steadier than the production of metals during the depression. The United States lagged behind the rest of the world in relative production of both coal and petroleum in 1934; the petroleum indexes stood at 105 for the United States and 156 for the rest of the world, while the coal and lignite indexes were 69 for the United States and 99 for the other countries. The United States made the poorest showing in the metals group; the index of production in 1934 was only 43 compared with 109 for rest of the world. Gold was the only important metal in the United States which has not remained well below the 1925–29 average. The United States index for gold production in 1934 was 135; the copper index was 27; pig iron, 41; aluminum, 42; lead, 45; silver, 51; and zinc, 60. This is in marked contrast with the total for other countries where, except for silver, the index of which was 77 in 1934, the metals were either above the 1925–29 average or very close to it.

Index numbers comparing quantity production of important metals and fuels in the United States with other countries of the world, 1930–34

[1925-29 average=100]

Year	Copper		Lead		Zinc		Gold	
	United States	Other countries	United States	Other countries	United States	Other countries	United States	Other countries
1930	78	117	87	110	83	125	100	108
1931	58	110	59	99	49	96	105	116
1932	30	81	39	90	35	78	108	127
1933	25	103	39	90	52	93	112	131
1934 [1]	27	131	45	102	60	111	135	140

Year	Silver		Aluminum		Pig iron		Total metals	
	United States	Other countries	United States	Other countries	United States	Other countries	United States	Other countries
1930	82	103	131	111	79	105	82	109
1931	50	86	101	94	47	79	54	94
1932	39	73	59	72	22	65	31	81
1933	37	72	49	70	38	73	39	90
1934 [1]	51	77	42	90	41	95	43	109

Year	Coal and lignite		Petroleum		Total fuels		Total metals and fuels	
	United States	Other countries	United States	Other countries	United States	Other countries	United States	Other countries
1930	89	103	103	136	100	109	95	109
1931	73	95	98	138	88	103	78	99
1932	60	89	90	139	78	98	64	92
1933	63	92	104	142	85	101	71	97
1934 [1]	69	99	105	156	91	110	77	110

[1] Subject to revision.

STATISTICAL SUMMARY OF MINERAL PRODUCTION

By M. B. Clark and E. T. Shuey

Mineral products of the United States, 1933–34 [1]

Product	1933		1934	
	Quantity	Value	Quantity	Value
METALLIC				
Aluminum .... pounds	85,126,000	$16,174,000	74,177,000	$14,094,000
Antimonial lead ...... short tons (2,000 pounds)	[2] 17,805	(2)	[2] 16,607	(2)
Antimony:				
Metal .... do	(3 4)	(3 4)	(3 4)	(3 4)
Ore (concentrates) .... do	1,133	(5)	897	(5)
Bauxite .... long tons (2,240 pounds)	154,176	923,259	157,838	1,129,053
Cadmium .... pounds	2,276,933	(5)	2,777,384	(5)
Chromite .... long tons	843	11,585	369	4,653
Copper, [6] sales value .... pounds	449,999,143	28,800,000	488,454,107	39,076,000
Ferro-alloys .... long tons	421,423	28,653,794	428,798	34,634,957
Gold .... troy ounces	[7] 2,556,246	[8] 65,337,648	[7] 3,075,192	[7] 107,631,700
Iron:				
Ore [4] .... long tons	24,624,285	[4] 63,776,033	25,792,606	[4] 66,483,846
Pig .... do	14,353,197	213,347,583	15,632,619	264,653,746
Lead (refined), [6] sales value .... short tons	259,616	19,212,000	299,841	22,188,000
Manganese ore (35 percent or more Mn) long tons	[9] 19,146	[9] 466,285	26,514	571,748
Manganiferous ore (5 to 35 percent Mn) long tons	191,631	529,204	221,822	621,090
Mercury:				
Metal .... flasks (76 pounds net)	[9] 9,669	[9] 572,666	15,445	1,140,845
Ore .... short tons	(10)	(11)	(10)	(11)
Nickel .... do	126	62,913	157	108,414
Ores (crude), old tailings, etc.:				
Copper .... do	8,385,000	(11)	(12)	(11)
Copper-lead and copper-lead-zinc .... do	126,000	(11)	(12)	(11)
Dry and siliceous (gold and silver) .... do	8,680,000	(11)	(12)	(11)
Lead .... do	3,213,000	(11)	(12)	(11)
Lead-zinc .... do	4,894,000	(11)	(12)	(11)
Zinc .... do	3,236,000	(11)	(12)	(11)
Platinum and allied metals (value at New York City) .... troy ounces	51,539	1,631,000	47,274	1,686,000
Silver [13] .... do	23,002,629	8,050,920	31,384,218	20,274,205
Tin (metallic equivalent) .... short tons	[9] 3	[9] 2,400	9	9,600
Titanium ore:				
Ilmenite .... do	(5)	(5)	(5)	(5)
Rutile .... do	(5)	(5)	(5)	(5)
Tungsten ore (60 percent concentrates) .... do	895	514,234	2,049	1,791,316
Uranium and vanadium ores .... do	105	4,119	(5)	(5)
Zinc, [6] sales value .... do	306,010	25,705,000	355,366	30,561,000
Total value of metallic products (approximate)		411,300,000		542,100,000

[1] In this general statement certain of the figures represent shipments rather than quantity mined, and some of the figures for 1934 are preliminary and subject to revision.
[2] Figures represent antimonial lead produced at primary refineries from both domestic and foreign primary and secondary sources; no figures for value of antimonial lead available. Estimate of value of primary antimony and lead contents of antimonial lead from domestic sources included in total value of metallic products.
[3] All from foreign ore in 1933 and largely from foreign ore in 1934; Bureau of Mines not at liberty to publish figures.
[4] Value not included in total value.
[5] Value included in total value of metallic products; Bureau of Mines not at liberty to publish figures.
[6] Product from domestic ores only.
[7] According to Bureau of the Mint. Valued in 1934 at $35.00 per ounce.
[8] Includes $52,842,300, calculated by Bureau of the Mint at legal coinage value ($20.67+ per ounce), plus $12,495,348 premium, calculated by Bureau of Mines at average weighted price ($25.56 per ounce).
[9] Revised figures.
[10] Figures not available.
[11] Figures showing values not available.
[12] Figures for 1934 not yet available.
[13] According to Bureau of the Mint.

Mineral products of the United States, 1933–34—Continued

Product	1933 Quantity	1933 Value	1934 Quantity	1934 Value
NONMETALLIC				
Arsenious oxide short tons	11,797	$636,132	15,623	$797,278
Asbestos do	4,745	130,677	5,087	158,347
Asphalt:				
Native do	313,135	1,705,310	440,852	2,365,750
Oil (including road oil) [4] do	2,122,458	[4] 15,946,191	2,515,628	[4] 23,413,386
Barite (crude) do	167,880	852,611	209,850	1,109,378
Borates (naturally occurring sodium borates and colemanite) short tons	188,047	3,436,377	242,500	4,822,014
Bromine pounds	10,147,960	2,040,352	15,344,290	3,227,425
Calcium-magnesium chloride short tons	57,813	893,442	76,719	1,153,159
Cement barrels (376 pounds net)	64,715,171	86,172,365	76,367,000	116,446,000
Clay:				
Products [14]		94,726,786		116,171,631
Raw [4] short tons	1,840,173	[4] 6,840,617	2,187,263	[4] 8,197,253
Coal:				
Bituminous [15] do	333,630,533	445,788,000	358,395,000	652,279,000
Pennsylvania anthracite do	49,541,344	206,718,405	57,385,000	243,312,000
Coke [4] do	[9] 27,589,194	[4] [9] 122,951,057	31,821,576	[4] 159,425,674
Diatomite and tripoli [16] do	20,878	350,383	20,529	329,356
Emery do	1,056	12,283	189	1,800
Feldspar (crude) long tons	150,633	778,826	154,188	853,136
Fluorspar short tons	72,930	1,039,178	85,786	1,391,405
Fuller's earth do	[9] 224,152	[9] 2,080,640	220,264	2,085,081
Garnet for abrasive purposes do	2,794	224,717	2,591	214,815
Gems and precious stones		(17)		(17)
Graphite:				
Amorphous short tons	(18)	(18)	(18)	(18)
Crystalline pounds			(18)	(18)
Grindstones and pulpstones short tons	14,176	444,250	12,630	463,234
Gypsum do	1,335,192	11,927,478	1,536,170	13,761,977
Helium cubic feet	(19)	(19)	(19)	(19)
Lime short tons	2,269,280	14,253,659	2,407,000	16,996,000
Magnesite (crude) do	108,187	840,000	100,973	730,630
Mica:				
Scrap do	8,751	98,159	7,719	99,791
Sheet pounds	364,540	53,179	583,528	90,268
Millstones		8,387		10,101
Mineral paints:				
Natural pigments [20] short tons	(20)	(20)	(20)	(20)
Zinc and lead pigments [21] do	129,355	13,193,627	114,661	12,617,296
Mineral waters gallons sold	(17)	(17)	(17)	(17)
Natural gas M cubic feet	1,555,474,000	368,540,000	1,950,000,000	405,000,000
Natural gasoline gallons	1,420,000,000	54,368,000	1,521,100,000	58,000,000
Oilstones, etc short tons	587	96,597	396	94,419
Peat do	(17)	(17)	40,544	214,185
Petroleum barrels (42 gallons)	905,656,000	608,000,000	909,345,000	900,000,000
Phosphate rock long tons	2,490,312	7,872,362	2,834,523	10,040,005
Potassium salts short tons	[22] 139,067	5,296,793	[22] 114,122	2,813,218
Pumice do	61,220	241,834	56,169	207,058
Pyrites long tons	284,311	769,942	432,524	1,216,363
Salt short tons	7,604,972	22,318,086	7,612,074	22,850,797
Sand and gravel:				
Glass sand do	1,781,423	3,011,023	1,920,000	65,000,000
Sand (molding, building, etc.) and gravel short tons	105,973,926	50,061,887	111,080,000	
Sand-lime brick [23] thousands	22,904	195,318	41,408	355,560

[4] Value not included in total value.
[9] Revised figures.
[14] Figures obtained through cooperation with Bureau of the Census.
[15] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.
[16] Figures represent tripoli only. Value of diatomite included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.
[17] No canvass. Estimate of value included in total value of nonmetallic products.
[18] Value included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.
[19] Value included in total value of nonmetallic products. For details of production in fiscal years see chapter of this volume on Helium.
[20] Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").
[21] Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.
[22] Equivalent as K_2O.
[23] According to Bureau of the Census.

Mineral products of the United States, 1933–34—Continued

Product	1933		1934	
	Quantity	Value	Quantity	Value
NONMETALLIC—continued				
Silica (quartz)......short tons..	11,153	$71,048	18,293	$129,965
Slate......do....	259,620	2,696,185	232,730	2,707,928
Stone......do....	70,222,210	80,945,608	86,617,000	94,456,000
Sulphur......long tons..	1,637,368	29,500,000	1,613,838	28,900,000
Sulphuric acid (60° Baumé) from copper and zinc smelters......short tons..	656,102	4,337,983	575,660	4,227,096
Talc and ground soapstone......do....	[9] 166,023	[9] 1,731,882	138,905	1,450,685
Total value of nonmetallic products (approximate)......	......	2,132,900,000	......	2,793,300,000
SUMMARY				
Total value of metallic products......	......	411,300,000	......	542,100,000
Total value of nonmetallic products (exclusive of mineral fuels)......	......	449,350,000	......	534,600,000
Total value of mineral fuels......	......	1,683,550,000	......	2,258,700,000
Total value of "unspecified" (metallic and nonmetallic) products (partly estimated) [24]......	......	10,900,000	......	[24] 14,600,000
Grand total approximate value of mineral products......	......	2,555,100,000	......	3,350,000,000

[9] Revised figures.
[24] Includes for 1934 the value of bismuth, cadmium compounds, chats ($504,910), flint lining for tube mills and pebbles for grinding, iodine ($342,957), iron ore sold for magnets, iron ore sold for paint ($26,151), lithium minerals ($20,980), new ingot magnesium, natural magnesium hydrate (brucite), natural magnesium salts ($1,266,325), calcareous marl ($22,236), greensand marl ($209,278), micaceous minerals ($123,796), molybdenum ($6,502,000), selenium, silica sand and sandstone (finely ground) ($1,392,173), sodium salts (carbonates and sulphates) from natural sources ($1,402,338), tantalum ore ($968), tellurium, and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Bureau of Mines.

WORLD PRODUCTION OF MINERALS AND ECONOMIC ASPECTS OF INTERNATIONAL MINERAL POLICIES

By J. S. McGrath and L. M. Jones

SUMMARY OUTLINE

MINERALS IN INTERNATIONAL TRADE

Unequal distribution of minerals.—Eighty percent of the total world production of the 28 major minerals of commerce is required to maintain the industries of only eight countries.[1] This fact reveals the unequal distribution of mineral resources and indicates the importance of all national policies that influence unrestricted movement of minerals in international trade.

Influence of national policies.—In the past the unhampered course or flow of mineral raw materials from the principal world sources of supply to industrial consumer nations has been determined broadly by economic considerations that may be identified with the free-trade school of thought. Recently, however, it has been altered seriously by a variety of restrictive and, in some instances, experimental national regulations that affect domestic development, importation, and exportation; in consequence the customary flow of minerals and metals in international trade is being deflected, with losses to established trade and investments. In some countries high-cost and marginal mineral enterprises are coming into production; although these do not appear justified by competitive conditions in world markets, they are supported for reasons of national defense or because of a forced or voluntary effort to achieve national self-sufficiency. Large world surpluses of mineral production and refining capacity thus are being created, which must be taken into account in considering the problems of domestic mineral producers.

As a nation the United States produces more of many commodities than it can consume, and in recent years frequent inability to dispose of existing stocks in some instances has forced a reduction of current

[1] Furness, J. W.. Mineral Raw Materials: Bur. For. and Dom. Commerce, 1929, p. 1.

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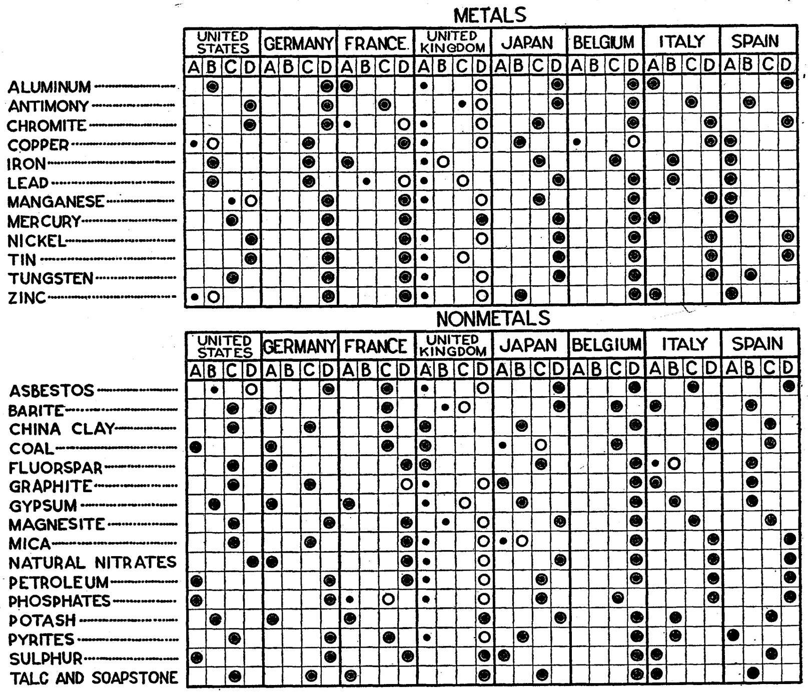
output. The Planning Committee for Mineral Policy appointed by President Roosevelt in April 1934 has stated that—

> The primary objectives of any foreign mineral policy of the United States are obviously (1) to facilitate imports, at low cost, of minerals not produced in the United States in sufficient abundance or proper grade to supply domestic needs, and (2) to secure markets for the few minerals existing in large quantities in the United States and efficiently produced in excess of its own requirements.

Opinions of the Planning Committee for Mineral Policy concerning international aspects of mineral policy, as set forth in the National



○ From within the political boundaries of the home country:
● From sources either politically or commercially controlled by the home country:
A-Minerals available for export.
B-Minerals adequate to meet domestic demands without appreciable excess or deficiency.
C-Minerals inadequate to meet domestic demands, or so located or of such grade as to require draft on foreign sources.
D-Minerals for which the country depends almost entirely on foreign sources.

FIGURE 8.—Indicated ability of important consuming countries to supply their needs for principal industria minerals. Data prepared by the Bureau of Foreign and Domestic Commerce.

Resources Board report of December 1, 1934, pages 441–449, have been drawn upon freely by the authors of this chapter.

Interdependence of nations.—The accompanying chart (fig. 8) illustrates the extensive interdependence of nations for mineral supplies.

Service of Bureau of Mines.—To assist industry to procure mineral raw materials of which the domestic supplies are inadequate to meet normal demand and to aid producers of those mineral commodities of which the United States has an exportable surplus, basic statistics on foreign mineral production must be readily available. Such data should be continuous, cumulative, and on a uniform basis to permit comparison. Since 1917 the United States Government, first through the Geological Survey and later through the Bureau of Mines, has collected, compiled, and published mineral production statistics of foreign countries and maintained a comprehensive bibliography relating to foreign mineral deposits and industries. For a detailed account of this phase of Bureau activity, see Minerals Yearbook, 1934, pages 13–15. Heretofore the Bureau has prepared, every 5 years, summary tables covering the variety and quantity of minerals produced by all foreign countries in the past half decade. The latest available report of this type is Mineral Production of the World, 1924–29, by L. M. Jones; it appears in Mineral Resources of the United States, 1930, part I, Bureau of Mines, pages 859–962. Those who may wish to carry forward the compilations given in the 5-year country summaries are referred to the following list of the principal tables on world production presented in this volume, with page numbers:

	Page		Page		Page
Aluminum	430	Feldspar	1113	Phosphate rock	1059
Antimony	545	Fluorspar	1105	Platinum	570
Arsenic	554	Graphite	1219	Potash	1160
Asbestos	1121	Gypsum	963	Pyrites	1027
Barite	1132	Iron ore	406	Salt	1042
Bauxite	430	Pig iron	411	Sulphur	1021
Briquets	718	Lead	93	Talc	1076
Cadmium	591	Magnesite	1170	Tin	515
Chromite	529	Manganese	482	Titanium	606
Coal	647	Mercury	460	Tungsten	496
Cobalt	594	Mica	1186	Zinc	118
Coke	682	Molybdenum	488		
Copper	68	Nickel	572		

In addition to these production data, the Bureau of Mines henceforth will compile trade statistics of foreign countries, that is, detailed figures covering exports from the principal producing countries and imports into the major industrial or consuming nations. Facilities are now available for compiling more accurate and inclusive information from foreign countries on the production of, competition in, and market demand for mineral commodities, and it is hoped that such information will furnish a more comprehensive basis for production adjustments, marketing procedure, and the establishment of domestic mineral policies. Data so obtained throughout the year will be released annually in World Summary of Production and Commerce in Minerals, a publication designed to supply in concise and handy form a comprehensive statistical digest of the production and trade in minerals of the various countries of the world. Additional nonstatistical economic information will be obtained through the consular offices of the State Department and foreign offices of the Department of Commerce, analyzed by the Bureau's commodity specialists, and published in the commodity chapters of Minerals Yearbook.

NATIONALISM AND MINERAL SELF-SUFFICIENCY

Self-sufficiency and national defense primary forces.—The desire for economic self-sufficiency and for assured national defense may account for the determined trend toward nationalism and a resultant closed-door policy in the mineral field evident in many countries during 1934. In the past year or two an additional compelling factor has been the effort to protect currencies and international trade positions. In the present state of world affairs, perhaps the dominant encouragement of nationalism is fear of extortionate prices and of being cut off from essential supplies in an emergency. Nations less fortunate than the United States in their endowment of natural resources have been trying to safeguard their position. For example, France requires importers of nitrates to keep a 3-month supply in stock and has forced the erection of petroleum refineries by means of oil import regulations. There is reason to believe that Great Britain, the U. S. S. R. (Russia), Japan, Germany, and France have imported raw materials for the manufacture of ferro-alloys in quantities that exceed their normal requirements. According to Chalmers,[2]

> During 1934 there was much activity abroad in the changing of tariffs, the adjustment of import quotas and exchange allotments, and in the negotiation of trade agreements between various countries. Allowing for certain exceptions, however, the net outcome appears to have left the general trade-control structure of the world as a whole about as restrictive as it was at the outset of the year.

In some countries, notably Germany, the situation has become more complicated because of developments during the year. On the other hand, modification of exchange-control systems of important Latin American countries has eased somewhat the restrictive effect upon their foreign trade.

Economic dependence on foreign sources.—A nation's dependence upon foreign sources for its mineral raw materials may be due to deficiency rather than to complete lack of domestic supplies, to shortage of desirable grades, or to disadvantageous location of domestic reserves in relation to markets. For one or another of these reasons the dependence of the United States upon specific countries for certain minerals, as shown in the following table, may be considered in the light of applied economics, that is, the purchase of necessities where the market is cheapest.

Mineral commodities in which the United States is wholly or partly deficient and principal foreign sources of supply

Commodity	Principal source	Alternate source
Antimony	China	Mexico.
Asbestos	Canada	Rhodesia, Union of South Africa, U. S. S. R.
Barite [1]	Germany	Netherlands.
Bauxite	Surinam	British Guiana.
China clay [1]	Great Britain	
Chromite	Rhodesia	Greece, New Caledonia, Cuba, Portuguese Africa, Turkey, U. S. S. R.
Fluorspar [1]	Germany	France, Spain.
Graphite [1]	Madagascar	Ceylon, Japan, Mexico.
Magnesite [1]	Austria	Czechoslovakia, U. S. S. R.
Manganese	Russia	Brazil, India, Gold Coast, Cuba.
Mercury	Spain	Italy.
Mica [1]	India	Canada, Madagascar.
Nickel	Canada	New Caledonia.
Nitrates (natural) [2]	Chile	
Pyrites [1]	Spain	Canada.
Talc [1]	Italy	France, Canada.
Tin	British Malaya	Hong Kong, Netherlands, United Kingdom.
Tungsten	China	Bolivia, Burma.

[1] Adequate reserves exist in the United States but their location with reference to centers of consumption is disadvantageous or their grades are not fully adapted to our uses.
[2] Domestic requirements for nitrate can be met entirely by synthetic production if necessary.

[2] Chalmers, Henry, Foreign Tariffs and Trade Controls During 1934: Commerce Repts., Feb. 9, 1935, p. 83.

These so-called "deficiency" and/or "strategic" mineral raw materials are necessary for balanced industrial production in peace and become vitally essential in war. It will be noted that the list of minerals for which the United States depends wholly or partly on foreign sources includes several that are abundant in this country. For some minerals, such as magnesite, the domestic deposits are of adequate size and suitable grade, but are so remote from centers of consumption that foreign supplies moving on low ocean-freight rates can be laid down in the United States at much lower delivered prices than domestic supplies can be shipped to points of consumption. However, this country more nearly approaches self-sufficiency in minerals than any other nation if the latter is considered from the angle of control of resources within the confines of the country and not from the viewpoint of political and commercial control of deposits throughout the world. Many studies have been made concerning certain minerals of which the domestic supply is inadequate. Proposals to provide stock-pile reserves of tin and manganese received considerable attention during 1934, and details thereon will be found in the separate commodity chapters of this volume. The National Resources Board concluded that although tariff protection has been used to stimulate domestic production of several minerals, figures on annual imports and domestic output since the tariffs became effective indicate that such protection has in general failed in its objective and that domestic production has not been stimulated to the point of assuring adequate supplies in an emergency. On the contrary, the Board states, importation of high-grade ores from the great supplies available in foreign countries continues despite the tariffs.

ECONOMIC FORCES TEND TO MODERATE STRICT NATIONALISM

Trade revival needed.—In most highly industrialized countries the lag in revival of trade with other countries appears attributable, in part at least, to the absence of any material change as yet in the spirit of intense nationalism that became accentuated during the depression and to the Government restriction of imports, by various means, that has characterized the trade policies of many countries during the past few years. An additional factor is the spread of industrialism among the so-called "backward nations", which has induced vital changes in their national policies. The rebuilding of a broader flow of international trade is predicated on recognition of distinct limits to the expansion of home markets. Hope for removal of trade barriers has been raised recently by the negotiation of reciprocal agreements between individual countries. The program initiated by the United States Government under authority granted by Congress through the passage of the Trade Reciprocity Act of 1934 involves the negotiation of a series of such trade agreements. The sponsors of this program hope to revive the flow of international trade through a progressive series of reciprocal trade-liberating agreements.

The commercial policy of the United States, as indicated by the Department of State,[3] is designed to accomplish two objects: (1) Mutual and reciprocal reductions in trade barriers and (2) removal or prevention of discriminations against American commerce. The

[3] Department of State, Policy of the United States Concerning the Generalization of Tariff Concessions under Trade Agreements: Press release, Apr. 1, 1935.

first of this series of agreements was that between the United States and Cuba, which became effective September 3, 1934; the second agreement, between this country and Brazil, was signed at Washington on February 2, 1935; a third agreement, with Belgium, and a fourth, with Haiti, were concluded early in 1935. Certain mineral commodities were involved in the first three agreements negotiated, and details may be found in the individual commodity chapters in this volume.

Exchange restrictions.—Significant factors in the congestion of international trade generally during 1934 were the exchange restrictions imposed by several countries. American Consul Lester L. Schnare, Hamburg, Germany, has reported [4]

> Importers' allotments of foreign exchange with which to pay for oil imports were reduced steadily during 1934 and were practically cut off in September. The importers were compelled (1) to stop importing, or (2) to allow the payments for their imports to accumulate in reichsmarks in Germany, or (3) to arrange for the purchase of German goods in exchange for the imports, unless they could import from countries with which Germany has arranged clearing agreements that avoid the effect of the exchange restrictions. The German Government has refused, with rare exceptions, to provide foreign exchange to pay for incoming shipments of mineral oils, notwithstanding that they are classed among the basic necessities.

To overcome the adverse effect on its foreign trade of restrictions previously placed on the sale of foreign exchange, Germany negotiated a number of clearing agreements with other countries during 1934. These clearing agreements, a form of credit arrangement, were expected to stimulate German export trade with the signatory countries. However, the actual result of these agreements has been an increase in German imports from those countries with which Germany has clearing agreements and a decided decrease in imports from nonsignatory countries, particularly the United States and Great Britain, with no material change in the status of export trade.

Barter transactions.—The steady growth of barter transactions continued throughout 1934. The following few examples of recent barter transactions may illustrate the degree to which this type of arrangement has invaded international trade: Iran (Persia) has placed orders in Sweden for rolling stock to the value of 5½ million kronor, or approximately $1,428,900, and bridge materials to the value of 4 million kronor, or about $1,039,200, in exchange for agricultural produce; France has exported to England 78,000 tons of pit props in exchange for 120,000 tons of coal; Italy is building two 30,000-ton liners for Poland in exchange for coal; Spain is importing Polish fuel for her Biscaya blast furnaces in exchange for ore.[5]

Trade agreements.—With respect to minerals, a number of agreements cross national boundaries and exercise considerable control of the production and marketing of these products. In certain instances these are primarily agreements between the producers and in some respects create an international trust or monopoly. In other cases, the governments of producing countries have become parties to the agreement and lend their authority to the measures of control initiated. According to the National Resources Board,

> A certain amount of unified commercial control, international in scope, is a natural consequence of the limited number of large sources of supply. For

[4] Bureau of Foreign and Domestic Commerce, International Petroleum Trade: Vol. 4, no. 4, Apr. 15, 1935, p. 9.
[5] Metal Bulletin (London), Apr. 2, 1935, p. 8.

some minerals there is already an approach to world monopoly by single companies or cooperating groups of companies or cartels, as illustrated by nickel, vanadium, aluminum, potash, asbestos, mercury, sulphur, natural nitrates, bismuth, and diamonds. For others, ownership is more divided but still in sufficiently few hands to make world cooperation potentially possible. In this category may be mentioned copper, iron, lead, oil, tin, and manganese. International combinations which may be classed as cartels have from time to time been formed for raw steel, zinc, copper, pig iron, sulphur, ferromanganese, aluminum, lead, mercury, diamonds, magnesite, nitrogenous fertilizers, tin, and for semifabricated and manufactured commodities, such as steel rails and tubes, and portland cement.

In the opinion of the Board, cooperative action among mineral producers in different countries may be desirable, and its encouragement rather than hindrance by the governments might combat the present trend toward exaggerated economic nationalism. Protection of consuming interests is essential and can be accomplished, states the Board, through effective representation in the operation of international agreements, and by publicity of current statistical data. Late in 1934, the International Tin Committee, representing only producers, announced that it would appoint an advisory board composed of representatives of the principal consuming interests in the major consuming countries.

On March 29, 1935, announcement was made[6] that copper producers representing companies having an aggregate current production of more than 75 percent of the total foreign primary output, exclusive of U. S. S. R. (Russia) and Japan, had negotiated the latest international agreement involving minerals. The conference that led up to the final agreement dealt exclusively with the foreign situation and did not consider production or sales within the United States, as the latter market is covered by the Code of Fair Competition for the Copper Industry, approved on April 21, 1934. Complete accord was reached by the participants upon the subjects of production control, marketing methods, and trade practices. Subject to certain contingencies, the term of this agreement is June 1, 1935, to July 1, 1938. Details concerning this agreement will be found in the chapter on Copper in this volume.

[6] Engineering and Mining Journal, April 1935, p. 189

PART II. METALS

GOLD AND SILVER

By Chas. W. Henderson

SUMMARY OUTLINE

GOLD

United States price for gold in 1933–35.—The Minerals Yearbook, 1934 (pp. 25–35), covers in detail the nearly world-wide increase in the currency price of gold that began in September 1931, when Great Britain went off the gold standard, the failure of this movement to affect the price for newly mined gold in the United States until August 9, 1933, and the United States Treasury regulations affecting the price of newly mined gold to June 1, 1934. The Treasury price of gold per fine ounce from January 1 to January 15, 1934, was $34.06; from January 16 to January 31 it was $34.45, and beginning February 1 it was increased to $35. The average weighted price for the calendar year 1934 was $34.95; for 1933 it was $25.56. The price in 1935, to June 1, has remained at $35.

Effect of price on gold mining.—The uncertainty of the price in 1933, coupled with physical factors, such as lack of development and normal exhaustion of certain ore bodies plus lowering of grade mined as the price increased, resulted in an increase in gold produced in 13 Western States and Alaska of only 0.1 percent for 1933 over 1932. The value increase (using $20.67+ for 1932 and $25.56 for 1933) was 23.79 percent. The seeming lack of assurance of permanence in price after February 1, 1934, brought little new capital into gold mining in 1934, but the treatment of lower-grade ore at established gold mines and the reopening of small mines—lifted out of the submarginal (below-profit) class to a near-profit or profit class—resulted in increases in 1934 as shown in the following table.

Mine production of gold in the United States, by regions, 1933–34, in terms of recovered metals

[Compiled by Chas. W. Henderson]

State or territory	Fine ounces				Value			
	1933	1934	Change in 1934		1933 (at $25.56 per ounce)	1934 (at $34.95 per ounce)	Change in 1934	
			Quantity	Percent			Dollars	Percent
Western States and Alaska:								
Arizona	79,992.61	[1] 165,000.00	+85,007.39	+106.3	$2,044,611	$5,766,750	+3,722,139	+182.0
California	613,578.85	719,063.92	+105,485.07	+17.2	15,683,075	25,131,284	+9,448,209	+60.2
Colorado	242,827.70	324,923.32	+82,095.62	+33.8	6,206,676	11,356,070	+5,149,394	+83.0
Idaho	64,592.23	[1] 83,600.00	+19,007.77	+29.4	1,650,977	2,921,820	+1,270,843	+77.0
Montana	57,822.20	[1] 97,822.00	+39,999.80	+69.2	1,477,935	3,418,879	+1,940,944	+131.3
Nevada	98,590.28	[1] 143,800.00	+45,209.72	+45.9	2,519,968	5,025,810	+2,505,842	+99.4
New Mexico	26,474.09	27,307.01	+832.92	+3.1	676,678	954,380	+277,702	+41.0
Oregon	20,239.66	33,711.59	+13,471.93	+66.6	517,326	1,178,220	+660,894	+127.8
South Dakota	512,403.77	486,118.97	−26,284.80	−5.1	13,097,040	16,989,858	+3,892,818	+29.7
Texas		358.74	+358.74			12,538	+12,538	
Utah	109,129.55	136,581.52	+27,451.97	+25.2	2,789,351	4,773,524	+1,984,173	+71.1
Washington	4,562.68	8,301.83	+3,739.15	+82.0	116,622	290,149	+173,527	+148.8
Wyoming	2,199.95	4,871.36	+2,671.41	+121.4	56,231	170,254	+114,023	+202.8
	1,832,413.57	2,231,460.26	+399,046.69	+21.8	46,836,490	77,989,536	+31,153,046	+66.5
Alaska	[2] 457,274.00	[2] 537,281.83	+80,007.83	+17.5	11,687,923	18,778,000	+7,090,077	+60.7
Total	2,289,687.57	2,768,742.09	+479,054.52	+20.9	58,524,413	96,767,536	+38,243,123	+65.3
Eastern States:								
Alabama	3.97	2,780.71	+2,776.74	(3)	101	97,186	+97,085	(3)
Georgia	558.40	969.91	+411.51	+73.7	14,272	33,898	+19,626	+137.5
Maryland	13.50		−13.50		345		−345	
North Carolina	724.64	508.70	−215.94	−29.8	18,522	17,779	−743	−4.0
Pennsylvania	208.98	623.00	+414.02	+198.1	5,342	21,774	+16,432	+307.6
South Carolina	234.57	642.03	+407.46	+173.7	5,996	22,439	+16,443	+274.2
Tennessee	223.49	455.00	+231.51	+103.6	5,712	15,902	+10,190	+178.4
Virginia	32.22	667.10	+634.88	(3)	824	23,315	+22,491	(3)
	1,999.77	6,646.45	+4,646.68	+232.4	51,114	232,293	+181,179	+354.5
Central States: Michigan	9.68	58.63	+48.95	+505.7	247	2,049	+1,802	+729.6
Philippine Islands	[4] 279,535.00	[4] 332,974.00	+53,439.00	+19.1	7,144,915	11,637,441	+4,492,526	+62.9
Puerto Rico	27.00	57.00	+30.00	+111.1	690	1,992	+1,302	+188.7
	279,562.00	333,031.00	+53,469.00	+19.1	7,145,605	11,639,433	+4,493,828	+62.9
	2,571,259.02	3,108,478.17	+537,219.15	+20.9	65,721,379	108,641,311	+42,919,932	+65.3

[1] Subject to slight revision.
[2] Refinery receipts.
[3] Increase more than 1,000 percent.
[4] Refinery figures.

GOLD MINING IN THE UNITED STATES

Study of the two tables by J. P. Dunlop that follow indicates (1) the trend in the source of gold in the United States from 1922 through 1933, showing clearly the importance of copper ore as a source of gold from 1923 through 1929, and (2) the average recovery of both gold and silver in ounces per ton by classes of ore in 1933. Complete returns for 1934 show that the output of dry and siliceous ore increased in California to 2,299,699 tons and that the recovered grade dropped to 0.193 ounce of gold per ton and increased to 0.335 ounce of silver per ton; in Colorado production of this class of ore increased to 1,164,575 tons with a drop in recovered grade to 0.259 ounce of gold per ton and an increase to 1.23 ounces of silver per ton; in South Dakota the output increased to 1,520,699 tons and recovered grade dropped to 0.312 ounce of gold per ton while in Utah it increased to 478,119 tons and the recovered grade decreased to 0.15 ounce of gold and 4.09 ounces of silver per ton. A study of these tables and available data for 1934 indicates that the price of $35.00 per fine ounce for gold will add to the unknown (unmeasured, but known to be relatively small compared to the large reserves of copper ore) siliceous-ore reserves but that, unless the known (large and sampled) reserves of copper ore containing gold (and silver) are worked, the annual United States production of gold in ounces will not continue to show material ncreases.

Gold produced in the United States, by sources, as reported by mines, 1922–33, and total fine ounces [1]

Year	Placers	Dry and siliceous ore	Copper-ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total fine ounces [2]
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
1922	23.46	68.06	5.71	1.54	0.12	0.11	1.00	2,293,251
1923	22.95	62.79	11.30	1.58	.14	.16	1.08	2,404,913
1924	18.44	65.56	12.70	1.63	.01	.08	1.58	2,444,331
1925	18.91	61.30	15.08	2.18	.02	.24	2.27	2,307,374
1926	20.50	58.03	16.36	2.05	.05	.15	2.86	2,232,526
1927	21.42	55.17	17.45	1.97	.07	.12	3.80	2,107,032
1928	19.41	55.67	19.31	1.67	.01	.32	3.61	2,148,064
1929	19.83	52.17	22.24	1.81	.06	.19	3.70	2,058,993
1930	20.59	59.27	15.57	1.24	.02	.15	3.16	2,138,724
1931	20.36	66.16	9.65	.79	----------	.05	2.99	2,224,729
1932	23.37	69.53	4.24	.68	----------	----------	2.18	2,330,020
1933	25.17	67.77	4.59	.59	.01	.01	1.86	2,303,709

[1] Philippine Islands and Puerto Rico excluded.
[2] Includes U. S. Geological Survey figures for Alaska.

Ore produced in the United States and average recovery in fine ounces of gold and silver per ton, 1929–33 [1]

State	Dry and siliceous ore			Copper ore			Lead ore			Zinc ore			Copper-lead and copper-lead-zinc ores			Lead-zinc ore			Total ore (short tons)
	Short tons	Average ounces per ton		Short tons	Average ounces per ton		Short tons	Average ounces per ton		Short tons	Average ounces per ton		Short tons	Average ounces per ton		Short tons	Average ounces per ton		
		Gold	Silver		Gold	Silver		Gold	Silver		Gold	Silver		Gold	Silver		Gold	Silver	
Alaska	4,171,000	0.053	0.03																4,171,000
Arizona	96,090	.257	1.41	888,508	0.053	2.38	11,029	0.251	12.67							101	0.254	4.46	995,728
California	1,281,843	.274	.28	38,176	.030	.13	1,257	.177	15.74	816	0.064	0.63	8	1.859	29.13				1,322,100
Colorado	741,900	.309	.89	91,133	.042	16.27	2,604	1.770	15.73				66	.017	14.91	9,792		.20	845,495
Idaho	131,187	.309	1.15	17	.737	4.71	630,305	.001	3.93				121,769		28.03	307,573	.001	3.05	1,190,851
Michigan	200	.048	.07	[2] 328,000		.38													328,200
Montana	167,237	.250	1.21	491,893	.009	3.28	7,425	.158	5.76	[3] 43,289		.22	60	.025	14.45	152,582	.010	5.18	862,486
Nevada	448,984	.178	1.74	1,197,498	.010	.06	1,583	.458	21.22	202			2,885	.011	11.21	27,302	.015	6.23	1,678,454
New Mexico	38,650	.116	3.63	1,100,707	.001	.02	877	.028	4.34	78,240			1,419	.008	15.76	255,946	.076	3.89	1,475,839
Oregon	11,508	.470	1.60				2	23.900	23.50							47	.015	1.98	11,557
South Dakota	1,432,555	.357	.09																1,432,555
Texas				45		1.40	18		5.39										63
Utah	150,007	.325	6.02	3,524,073	.010	.10	62,319	.056	18.61	47						380,489	.056	8.55	4,116,935
Washington	5,275	.676	2.75				230	.030	2.55							48,479		.07	53,984
Wyoming	1,071	.342	.06																1,071
Eastern States	2,869	.248	.06	[4] 703,536	.001	.08				([5])						([5])			[6] 706,405
1933: Total	8,680,376	.180	.42	8,363,586	.013	.70	717,649	.019	5.47	122,594	.002	.58	126,207	.001	27.49	1,182,311	.036	5.20	19,192,723
Percentage	45.23			43.57			3.74			0.64			0.66			6.16			100.00
1932: Total	8,226,167	.197	.48	11,504,946	.009	.45	697,168	.023	7.02	41,410		.07	167,106		20.18	815,177	.062	6.49	21,451,974
Percentage	38.35			53.63			3.25			0.19			0.78			3.80			100.00
1931: Total	8,329,009	.177	.52	30,966,550	.007	.31	894,636	.020	6.84	97,950		.06	213,245	.006	13.09	1,484,530	.045	4.69	41,985,920
1930: Total	7,767,289	.161	1.13	41,723,797	.008	.33	1,380,641	.019	6.36	249,366	.001	1.80	246,430	.013	12.38	2,604,926	.026	5.01	53,972,449
1929: Total	7,671,150	.140	.145	62,140,833	.007	.29	1,592,043	.023	7.35	494,372	.003	3.19	259,126	.015	10.95	3,496,400	.022	4.47	75,653,924

[1] Illinois, Missouri, Philippine Islands, and Puerto Rico excluded; quantity of crude ore containing gold and silver unknown.
[2] Includes only copper ore that yielded silver.
[3] Includes 42,510 tons of current slag fumed.
[4] Includes pyritiferous magnetite ore from Pennsylvania yielding 2,158 tons of copper concentrates.
[5] Zinc ore and lead-zinc ore yielded no gold or silver.
[6] Includes low-grade pyritiferous magnetite ore from Pennsylvania; excludes ore containing no gold or silver.

Alaska.—Two large mining operations in Alaska will continue to assure a stabilized gold production for that Territory—the low-grade Alaska Juneau lode mine, and the 5 modern floating dredge boats of the Fairbanks Exploration Co. in the Yukon district and the 3 modern dredges of the Hammon Consolidated Gold Fields at Nome, both subsidiaries of the United States Smelting, Refining & Mining Co. The following excerpts from the annual reports for the calendar year 1934 of these operations give a clue to their future.

The Twentieth Annual Report of the Alaska Juneau Gold Mining Co. for the year ended December 31, 1934 (dated Mar. 5, 1935) says:

The profit of $2,221,315.48 earned in 1934, before depreciation, was 20 percent greater than that earned in 1933. This increase occurred in spite of a 15-percent decrease in gold production and was due entirely to the advance in the price of gold.

The gold production fell off because the ore from the South Orebody, about 90 percent of the total mine production, was of lower than average grade, and at the same time the increase in production of deep level ore was but nominal.

At this date the production of ore from the lower levels is 15 percent of the total mine output, and the indications are for an improvement in grade of South Orebody ore, though not to the peak level of previous years. The expectation for the forthcoming year is a gold output that will maintain present dividend payments, provide for some abnormal capital expenditures, and permit an increase in cash surplus.

Successful negotiations were completed for the purchase of all mining claims, power plants, and all other physical property in Alaska, belonging to Alaska Mining & Power Co. There was paid for this property 84,703 shares of Alaska Juneau Gold Mining Co. stock, which was bought in the open market and used for this special and specific purpose.

The extension of the Alaska Juneau workings into the newly acquired property began immediately after the purchase was completed. The development and preparatory mining work will be pressed and a block of ground will be prepared for large-scale production. This program will be the first of several in the development of this property, but it will not be 100 percent completed for about 3 years, although some production will begin well before that time has elapsed. The ultimate future of this property will not be known until developments have extended into those areas of the property about which little is known at present. The immediate advantage arising out of the ownership lies in reduced power costs; the ultimate advantages are a prolonged life for our operations, with an increase in their scale providing development results justify.

The general superintendent's report follows with its usual statistical and general information. It will be noted that no work was done on outside prospects in British Columbia or Alaska, although a number of properties were investigated. Some work was done on a property in Oregon, but this venture will be abandoned. Your company has taken over the management of a group of properties in California and will have a preferred position for acquiring ownership in case development work indicates a promising future.

Alaska Juneau Gold Mining Co., Alaska, 1934

STATEMENT OF EARNINGS AND PROFIT AND LOSS FOR YEAR ENDED DECEMBER 31, 1934

Production revenue (gross recovered values):			
From 128,015,257 fine ounces gold		$4, 465, 354. 31	
From 86,458.27 fine ounces silver		53, 842. 93	
From 1,662,894 pounds lead		63, 361. 73	
			$4, 582, 558. 97
Less operating and marketing costs			2, 409, 046. 61
Gross profit from production			2, 173, 512. 36
Other revenue:			
Interest and sundry		68, 250. 87	
Less other costs:			
Stock-transfer expense	$13, 096. 70		
Outside prospecting	7, 351. 05		
		20, 447. 75	
			47, 803. 12
Profit before depreciation and income taxes			2, 221, 315. 48
Sustained plant depreciation		99, 243. 07	
Accrued income taxes for year		199, 306. 48	
			298, 549. 55
Net profit before depletion			1, 922, 765. 93
Deduct common dividends paid in 1934			1, 760, 549. 10
			162, 216. 83
Surplus at December 31, 1933 (as adjusted)			2, 706, 634. 06
Surplus at December 31, 1934 (before depletion)			2, 868, 850. 89

Development and preparatory mining work done by Alaska Juneau Gold Mining Co., Alaska, 1934

Level	Drifts and cross-cuts	Raises	Powder drifts	Inter-mediate drifts	Sta-tions	Bull-dozing cham-bers	Winzes	Total, feet	Square feet of stope area cut out
No. 00 south			154				10	164	
No. 1 south	901		217				13	1, 131	
No. 2 south	589	1, 139	988				53	2, 769	17, 916
Sublevel south			90					90	
No. 3 south		179	39			55	8	281	
No. 4 south	756	139						895	
No. 4 north	48	265						313	
No. 6 north	343	117						460	
No. 7 north	270		305				80	655	
No. 8 north	42	2, 162				119	24	2, 347	24, 396
No. 9 north	519		91				54	664	
No. 950 north	811		296				13	1, 120	
No. 10 north	1, 104	1, 018		437	13	231		2, 803	2, 961
Total	5, 383	5, 019	2, 180	437	13	405	255	13, 692	45, 273

Complete record of all underground work done in the Alaska Juneau mine from the beginning of 1911 to the end of 1934

Year	Drifts and cross-cuts	Raises	Winzes	Inter-mediate drifts	Powder drifts	Bull-dozing cham-bers	Sta-tions	Total, feet	Slope area of stope cut out, square feet
1911	326	--------	--------	--------	--------	--------	--------	326	--------
1912	3,950	--------	--------	--------	--------	--------	--------	3,950	--------
1913	2,155	599	--------	--------	--------	--------	200	2,954	--------
1914	3,284	1,418	--------	618	--------	--------	420	5,740	53,997
1915	7,162	5,468	--------	3,000	281	--------	864	16,775	87,943
1916	8,958	7,457	--------	1,986	2,645	--------	1,531	22,577	110,261
1917	6,271	7,967	--------	--------	9,012	212	279	23,741	14,261
1918	2,109	1,528	213	132	1,386	125	8	5,501	54,068
1919	3,150	4,304	--------	714	2,087	273	286	10,814	33,996
1920	1,924	2,510	--------	279	4,322	93	232	9,360	18,653
1921	171	1,698	--------	200	1,814	--------	99	3,982	11,238
1922	1,071	2,291	--------	172	1,907	60	52	5,553	33,448
1923	4,128	3,144	185	450	2,444	--------	91	10,442	16,428
1924	3,075	4,635	103	514	1,689	46	98	10,160	27,079
1925	5,192	4,207	--------	80	2,404	--------	--------	11,883	81,293
1926	2,960	4,469	131	147	2,589	--------	--------	10,296	57,548
1927	4,277	5,189	--------	287	2,729	54	60	12,596	32,251
1928	5,955	6,113	30	315	2,603	45	24	15,085	60,967
1929	5,590	5,231	--------	50	1,532	42	82	12,527	81,635
1930	4,362	4,208	311	517	3,733	36	18	13,185	63,072
1931	4,849	4,425	832	774	2,368	60	201	13,509	22,099
1932	9,722	5,478	1,525	123	850	244	254	18,196	24,546
1933	9,998	8,162	206	376	1,328	377	286	20,733	56,873
1934	5,383	5,019	255	437	2,180	405	13	13,692	45,273
Total	106,022	95,520	3,791	11,171	49,903	2,072	5,098	273,577	986,929

The amount of work done in previous years and the amount of work done during the year 1934 in the 53 winze area of the North Ore Body below Gold Creek Tunnel Level, together with the average gold assay value for each level, are shown in the table below:

	1930–33, inclusive		1934		Total	
	Feet	Gold assay	Feet	Gold assay	Feet	Gold [1] assay
4 level	94	$3.81	--------	--------	94	$3.81
5 level	148	3.28	--------	--------	148	3.28
6 level	1,411	1.90	460	$0.88	1,871	1.65
7 level	2,377	1.95	270	1.33	2,647	1.89
8 level	5,671	2.27	2,323	1.71	7,994	1.07
9 level	2,720	1.80	519	1.01	3,239	1.67
950 level	2,669	1.62	811	.60	3,480	1.38
10 level	5,994	1.34	1,335	1.21	7,329	1.32
Total drifts and winzes	21,084	1.81	5,718	1.29	26,802	1.70
Total diamond-drill holes	4,515	1.17	550	1.10	5,065	1.16
Total development	25,599	1.70	6,268	1.27	31,867	1.61

[1] Based on $20.67 per ounce.

The work of enlarging the main shaft to four compartments, each 6½ feet by 6½ feet inside the timber, was completed in early July. It had been expected to complete all station work, both on the No. 4 Level and at the No. 10 Loading Station, while enlarging the shaft was in progress, but for various reasons this was not found expedient. It was not until August that the stations were ready for installing the hoist and accessories and the gates at the loading pocket. Enlarging the shaft and cutting the stations required the breaking and handling of 18,000 cubic yards of solid rock.

In August the work of installing the 800-hp. hoist in the Main Shaft was begun, and at the same time work was started on the installation of the loading and dumping devices. On November 21 the installation was completed to a point where hoisting was begun. After only a few hours use, defects appeared in parts of the accessory equipment, and several weeks' time was lost in securing and installing replacements. Since then the hoist has been operating smoothly and efficiently and has performed fully in accordance with all expectations.

Labor.—As in the previous year, there was an abundant supply of labor, although the number of skilled miners applying was not large. Many applications for employment were received by letter, but the policy of hiring men locally was adhered to.

On July 1, in order to assist the Government in its policy of spreading employment, a 6-day work week was adopted. Owing to this and a further increase in development and construction work, the number of employees on the pay roll for the last half of the year was some 200 more than in the previous year.

Owing to wage increases made to maintain the purchasing power of employees under the shorter work week, the average daily wage was increased from $5.22 at the first of the year to $6.05 at the end of the year. The average wage for the year was $5.67, and the over-all cost per man per day was $9.82.

The Twenty-ninth Annual Report of the United States Smelting Refining & Mining Co. for the year ended December 31, 1934 (dated Mar. 27, 1935) contains the following comments on its Alaskan operations:

At Fairbanks, Alaska, aided by favorable weather and a good supply of water, the dredging season was about 8 days longer than last year, and a greater yardage of gravel was dug than in any preceding year. While average grade of the gravels dug was lower than last year, this being partly due to the inclusion of lower-grade gravels made profitable by the higher price of gold, the output of gold was slightly greater than in 1933. On the newly acquired dredging areas in the Fairbanks district, referred to in the report for last year, interior drilling has more definitely proven the commercial values therein, while limit drilling has substantially increased the extent of the probable dredging areas. Additional equipment necessary to strip and thaw these areas in preparation for dredging was installed, and stripping operations were started. The deep gravels in part of these new areas will be dug by a large dredge now being designed for the purpose. The shallower gravels will be dug by one of the smaller dredges.

As a result of the decision in 1932 to abandon the dredging fields at Nome, Alaska, which decision was subsequently reconsidered, the dredging areas sufficiently prepared for 1934 digging were limited, and only one of the three dredges dug throughout the season, while a second dredge was started in the middle of August. During the season an extensive thawing campaign was carried on, and equipment was installed to increase the water supply necessary for this purpose. Rehabilitation of the third dredge was completed by the end of the year. Further acquisitions of ground were made. It is expected that all three of the dredges will be in operation the coming season. As stated in previous reports, all earnings from the Nome fields for the last few years, including 1934, have been set aside in reserve to amortize the investment. In view of the previously reported acquisitions of additional ground and the present outlook for continuing future operations, effective with the season of 1935, the remaining balance of the investment, together with additions thereto, will be amortized on the basis of available dredging reserves and the gold extraction therefrom, and resulting profit from these operations, if any, after deducting the required reserves for amortization, will be included in the reported earnings.

Another important producer in Alaska in 1934 was the Willow Creek Mines, Ltd., in the Willow Creek district north of Anchorage.

Arizona.—The tonnage of ore treated in Arizona dropped from 25,860,772 tons (mostly copper ore) in 1929 to 995,728 tons (89 percent copper ore) in 1933 but was 3,220,000 tons (88 percent copper ore and 9 percent dry and siliceous ore) in 1934. The 202,318.14 fine ounces of gold produced in 1929 was worth $4,182,287 at $20.67 per fine ounce; the 165,000 ounces (45 percent from copper ores and 45 percent from siliceous gold ores) produced in 1934, at $34.95 per fine ounce, was worth $5,766,750. The gain in ounces produced in 1934 over 1933 was caused by a large increase in the output of copper ores and a material increase in the output of siliceous gold ore. Recoveries from Arizona copper ores in 1929 were 0.007 ounce of gold, and 0.257 ounce of silver per ton; in 1933, 0.053 ounce of gold and 2.38 ounces of silver per ton. Dry and siliceous ore (96,090 tons) treated in Arizona in 1933 yielded 0.257 ounce of gold and 1.41 ounces of silver per ton. The larger gold production of Arizona in 1934 resulted from the resumption of milling of copper ore at the New Cornelia and Miami Copper mines and the increased output of copper ore from the Copper Queen Branch of the Phelps Dodge Corporation. There was also a material increase in output of gold ore from the mines at Oatman, Katherine, and Mammoth and from mines near Prescott, Hillside, Wickenburg, Vicksburg, and Superior. The copper smelters at Douglas, Clemenceau, and Superior continued operations during 1934, but the smelting plants at Hayden, Clifton, Miami, and Clarkdale were idle. The Copper Queen Branch at Bisbee increased its output of copper 26 percent and was, as in 1933, the largest producer of gold in Arizona. It was followed by the Superior & Arizona Lease at Superior, the New Cornelia at Ajo, the Tom Reed at Oatman, the United Verde Extension at Jerome, the Magma Copper mine at Superior (where there was also a marked increase in copper production), the Big Jim at Oatman, the Gold Standard at Katherine, the Sheeptanks near Vicksburg, the Hillside near Hillside, the Gladstone-McCabe near Prescott, the Tombstone group at Tombstone, the United American at Oatman, the Montana at Ruby, the dredge near Prescott, the New Year-Mammoth near Mammoth, the Ace southeast of Phoenix, and the Tyro at Katherine.

California.—California produced 719,064 fine ounces of gold in 1934 compared with 613,579 ounces in 1933, an increase of 105,485 ounces. The increase from lode mines was 92,839 ounces, and the increase from placer mines only 12,646 ounces. The placer increase seemed to come from drag-line and power-shovel excavators and small individual placers, as the output from floating dredges decreased 7,659 ounces, that from drift placer mines decreased 3,988 ounces, and that from hydraulic placers increased only 4,787 ounces. The Grass Valley-Nevada City district (chiefly lode gold) ranked first in the State in gold production with an output of 192,819 ounces. The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—contributed 163,564 ounces or 23 percent of the State total (placer and lode combined). As usual, the bulk of the production of lode gold came from old established operators. The following 20 companies in the State, listed in order of output, produced 75.2 percent of the lode gold and 46.5 percent of the total California gold output: Empire Star Mines Co., Ltd., Nevada County; Idaho Maryland Mines Co., Nevada County; Argonaut Mining Co., Ltd., Amador County; Carson Hill Gold Mining Corporation, Calaveras County; Mountain Copper Co., Ltd., Shasta County; Original Sixteen to One Mine, Inc., Sierra County; Kennedy Mining & Milling Co., Amador County; Montezuma Apex Mining Co., Eldorado County; Central Eureka Mining Co., Amador County; Central Tailings Co., Amador County; Golden Center, Nevada County; Beebe Gold Mining Co., Eldorado County; Lava Cap Gold Mining Corporation, Nevada County; Pacific Mining Co., Mariposa County; Spanish Mining Co., Nevada County; Middle Fork Gold Mining Co., Eldorado County; Silver Queen Mining Co., Kern County; Kenton mine, Sierra County; Cardinal Gold Mining Co., Inyo County; and King Solomon Mines Co., Siskiyou County.

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The production of gold by floating dredge boats was 194,051 ounces—approximately 27 percent of the gold output of the State. The Natomas Co. with 6 dredges and the Capital Dredging Co. with 3 dredges, in the Folsom district, Sacramento County, and the Yuba Consolidated Gold Fields with 5 dredges in the Yuba River district, Yuba County, and 1 dredge in the Snelling district, Merced County, were the largest operators and together produced over 75 percent of the total dredge output.

Colorado.—The rising price of gold from August through December 1933 and continuance of the price of $35 per fine ounce from February 1 through December 1934 resulted in a revivification of Colorado gold mining. If the price continues, lower-grade ores will become minable. The result was most apparent in the old districts of Boulder County, where production had been very low for many years. This county increased its production from 4,402.51 ounces in 1933 to 17,536.48 ounces in 1934. Clear Creek and Gilpin Counties also increased their output of gold but not in the same proportion as Boulder. The largest increases were 25,721.31 ounces in Park County, where the ore has been high enough in grade to make a profit at the old price of $20.67 per ounce of gold and where the increased price affected only placer output; 18,081.52 ounces in Teller County (Cripple Creek district), where mining has been saved largely as an effect of the increased price; and 13,133.97 ounces in Boulder. The largest decrease was 6,881.88 ounces in San Juan County.

Eastern States.—The output of gold in the Eastern States was 6,646.45 fine ounces in 1934—4,646.68 ounces more than in 1933. Placer mines yielded 874.34 fine ounces of gold compared with 663.37 ounces in 1933. One mine in Alabama and one in Virginia produced more than half of the gold recovered in the Eastern States, but few of the new mines or old mines reopened made a large output. Mines in Alabama yielded 2,780.71 ounces of gold in 1934, which was nearly as much as the combined output of Georgia, North Carolina, South Carolina, and Virginia in that year. There was a small production of placer gold, but the output was mainly lode gold from the Hog Mountain Gold Mining & Milling Co. about 15 miles from Alexander City in Tallapoosa County, which mined and milled more gold ore in 1934 than the combined output of such ore in the southern tier of Eastern States for many years. This mine was discovered in 1839. Its total production of gold in unknown, but its yield for the period 1893 to 1915 is estimated at about $250,000.

Idaho.—Although ranking well as a silver- and lead-producing State, Idaho's past record does not place it among the prominent gold-producing States. In 1934 it produced 83,600 ounces of gold, an increase of 29 percent over 1933. Most of the increase (19,000 ounces) came from lode mines. The Boise-Rochester lode property of the St. Joseph Lead Co. at Atlanta (a reopening during the last few years of an old property) in 1934 was by far the largest gold producer in the State, with an increase of 11,000 ounces over 1933. The Yellow Pine Co. lode mine at Stibnite was the second largest gold producer in the State, producing about the same quantity in 1934 as in 1933. Substantial increases in lode-mine gold were also made at the Talache at Quartzburg, the Come Back at Pioneerville, the Four Square at Murray, the Golden Chariot at Silver City, and the Grunter at Shoup. The Gnome lode property near Elk City did not equal its 1933 production.

The output of 26,300 ounces from placers was an increase of 13 percent over 1933. More than half the placer yield was produced by the two floating dredges at Warren, Idaho. The Idaho Gold Dredging Co. was third in rank for both lode and placer output, and the Warren Creek Dredging Co. was fourth; the output of these dredges, however, was nearly 10 percent less than in 1933. The increase in placer-gold production was chiefly from the property operated by McFarland and Witham near Placerville, Boise County.

Montana.—Montana, which contains the camp with the largest single total production in the United States—Butte, with its copper-silver and zinc-lead-silver ores, both carrying some gold—has produced a total in gold for the whole State almost identical to that of South Dakota.

Montana increased its gold production from 57,822 ounces in 1933 to 97,822 in 1934, chiefly due to the output of the two new floating dredges in Powell County and the Winston Bros. dry-land dredge on Prickly Pear Creek in Jefferson County. In fact, the largest gold producers in the State were the two floating dredges. These are the Pioneer dredge operated by the Yuba Associated Engineers, Ltd., on Gold Creek and the dredge on Ophir Creek operated by the Yuba Consolidated Gold Fields. The dry-land dredge was sixth in order of production of both placer and lode mines. These dredges are on old placer ground made minable by the increase in the gold price.

The output from old lode mines also increased over 1933. In order of gold production were the Little Ben (August), Jay Gould, Jardine, Boss Tweed-Clipper, Thompson Gold Milling Co. (formerly I. B.), Anaconda Copper Co. mines at Butte, Gold Coin, Hidden Lake, Prospect, Ohio-Keating, Drumlummon, Liberty Montana, B. & H. (Inspiration), Grant & Hartford, Scratch Gravel, and Spring Hill. The increase in lode production was noted chiefly in the Bannack district (Beaverhead County), Beaver and Cedar Plains districts (Broadwater County), First Chance and Hidden Lake districts (Granite County), Helena, Ottawa, Scratch Gravel, and Stemple districts (Lewis and Clark County), Mineral Hill, Sheridan, and Tidal Wave districts (Madison County), and Little Rockies district (Phillips County).

Nevada.—Higher prices for copper, gold, and silver in 1934 resulted in an increase of gold production in Nevada to 143,800 ounces compared with 98,590 ounces in 1933. This production is the largest since 1930 but is still below that for 1929. The Nevada Consolidated Copper Corporation operated its mines at Ruth and smelter at McGill at a slightly greater capacity than in 1933, when only about 20 percent of the full capacity was utilized. Despite improvements in other gold-producing districts in Nevada the Nevada Consolidated Copper Corporation continued to be the leading producer of gold in Nevada. Other important gold producers were White Caps Gold Mining Co., Manhattan district; Nevada Porphyry Gold Mines, Inc., Round Mountain district; Mary mine, Silver Peak district; Bradshaw Syndicate, Inc. (Goldfield Consolidated Mines Co. tailings dump), Goldfield district; Dayton Consolidated Mining Co., Silver City district; and Tonopah Mining Co. (lessees), Tonopah district.

New Mexico.—In New Mexico gold production came chiefly from the lead-silver-gold-copper concentrates of the Pecos zinc-lead mine at Tererro, gold-silver concentrates and cyanidation bullion from Mogollon, and gold ores and concentrates from Pinos Altos. Placer-gold output was 2,587.64 ounces in 1934 compared with 1,399.15 ounces in 1933. The increase was due chiefly to better success in the handling of dry-land excavating machines.

Oregon.—The Oregon gold production of 33,711.59 fine ounces valued at $1,178,220, calculated at $34.95 per fine ounce, represented 96.9 percent of the total value of the gold, silver, copper, lead, and zinc recovered from ores and gravels treated in the State in 1934. Placer mines furnished 22,239.91 fine ounces (66 percent of the State gold), nearly twice the output of lode gold. Four floating dredges produced 9,254.47 fine ounces. They were operated by the Pioneer Gold Dredging Co., Baker County; Monarch Gold Dredging Co. (old Empire dredge) and Timms Gold Dredging Co., Grant County; and Rogue River Gold Co., Jackson County. These four dredges handled 1,912,302 cubic yards of gravel and made an average recovery of 0.0048 ounce of fine gold per cubic yard. Hydraulic mining yielded 2,214.98 ounces, drift mining 1,038.73 ounces, and other placer mining methods (drag-line and power-shovel operations, sluicing, rocking, and panning) 9,731.75 ounces. The production of itinerant placer miners formed an important part of the total placer output. Jackson County produced 29.8 percent of the placer gold, Grant County 24.5 percent, Baker County 20.5 percent, and Josephine County 19.5 percent.

Baker County was by far the largest producer of lode gold. The Cornucopia Gold Mines, Inc., at Cornucopia, Baker County, was the largest producer of gold (and silver) in Oregon. The other principal lode-gold-producing counties were Jackson, Josephine, Lane, and Grant.

South Dakota.—As usual, the bulk of the output of gold from South Dakota came from the long-lived (1876 to date) and well-developed Homestake mine at Lead. The increased price of gold in 1933 resulted in the reopening of two mines closed since 1923, and the still higher price in 1934 resulted in the reopening of several idle for 35 years.

Utah.—Utah has not been known as one of the large gold-producing States; much of its output of 7,136,891 ounces (1864–1934) has come from the small gold content of the copper ore handled for many years on a large scale (reaching 80,000 tons a day in 1929) by the Utah Copper Co. In 1934 the output of gold in Utah was 136,581.52 ounces compared with 240,419.63 ounces in 1929. Compared with the 1933 output (109,129.55 ounces) the output in 1934 represented an increase of 25 percent. Siliceous ore and old tailings in 1934 were the source of 52.75 percent of the total gold compared with 44 percent in 1933; copper ore comprised 32.34 percent of the total in 1934 compared with 33 percent in 1933; lead-zinc ore furnished 11.17 percent in 1934 and 20 percent in 1933. Copper ore in 1929 furnished 57.1 percent of the 240,420 ounces produced that year. The largest producers of gold in Utah in 1934 were the Utah Copper, Eureka

Standard, United States, Manning Co. (old Mercur gold tailings retreated), Utah Delaware, Mammoth, and Eureka Lilly. These seven properties (each with a production of 4,500 or more ounces) yielded 74 percent of the State total. Placer mines in Utah yielded 128.04 ounces of gold in 1934 compared with 142.51 ounces in 1933.

Washington.—Of the Washington gold production—8,301.83 ounces—nearly 4,000 ounces were contained in ore shipped chiefly to smelters from mines in the Republic district, Ferry County; most of the remainder came from lode and placer mines in Stevens County. The Knob Hill mine at Republic was the largest producer of gold in Washington, followed closely by the First Thought mine at Orient.

Wyoming.—The gold output of Wyoming, principally from lode and placer mines in the Atlantic City district, increased from 2,200 ounces in 1933 to 4,871 ounces in 1934.

SILVER

Newly mined silver receives 64.6464+ cents per fine ounce by Presidential proclamation of December 21, 1933.—On December 21, 1933, President Roosevelt issued a proclamation that gave \$0.64646464+ (one-half of \$1.2929292929+) per fine ounce to producers of newly mined silver. The average New York and London spot prices of silver for 1933 by months had been as follows:

Silver prices, average New York and London spot, 1933, by months

	New York	London spot		New York	London spot
	Cents	*Pence*		*Cents*	*Pence*
January	25.400	16.883	August	36.074	17.877
February	26.074	16.885	September	38.440	18.272
March	27.928	17.588	October	38.190	18.221
April	30.730	18.440	November	42.974	18.248
May	34.072	19.046	December	43.550	18.674
June	35.663	19.078			
July	37.630	18.341	Average for year 1933	34.727	18.144

The results of this proclamation were the reopening almost immediately of those mines which had known reserves but had closed in July 1930 when silver reached 30 cents an ounce, such as the Presidio mine at Shafter, Tex., and the mines at Creede, Colo., and an increase in production of those which had struggled to exist from 1930–33, such as the silver-lead mines of Utah and Idaho. The following table shows the comparative silver production by States and Territories for 1933 and 1934.

Mine production of silver in the United States, by regions, 1933–34, in terms of recovered metal

[Compiled by Chas. W. Henderson]

State or Territory	Fine ounces				Value			
	1933	1934	Change in 1934		1933 (at $0.35 per ounce)	1934 (at $0.6464646464 per ounce)	Change in 1934	
			Quantity	Percent			Dollars	Percent
Western States and Alaska:								
Arizona	2,390,363	[1] 4,420,000	+2,029,637	+84.9	$836,627	$2,857,374	+2,020,747	+241.5
California	402,591	844,413	+441,822	+109.7	140,907	545,883	+404,976	+287.4
Colorado	2,186,140	3,475,661	+1,289,521	+58.9	765,149	2,246,892	+1,481,743	+193.7
Idaho	6,987,960	[1] 7,410,000	+422,040	+6.0	2,445,786	4,790,303	+2,344,517	+95.9
Montana	2,660,700	[1] 3,958,000	+1,297,300	+48.8	931,245	2,558,707	+1,627,462	+174.8
Nevada	1,148,621	[1] 2,850,000	+1,701,379	+148.1	402,017	1,842,424	+1,440,407	+358.3
New Mexico	1,181,580	1,061,775	−119,805	−10.1	413,553	686,400	+272,847	+65.9
Oregon	20,760	46,562	+25,802	+124.3	7,266	30,100	+22,834	+314.3
South Dakota	125,417	99,741	−25,676	−20.5	43,896	64,479	+20,583	+46.9
Texas	160	854,442	+854,282	(2)	56	552,367	+552,311	(2)
Utah	5,669,197	7,111,417	+1,442,220	+25.4	1,984,219	4,597,280	+2,613,061	+131.7
Washington	18,520	44,120	+25,600	+138.2	6,482	28,522	+22,040	+340.0
Wyoming	260	710	+450	+173.0	91	459	+368	+404.4
	22,792,269	32,176,841	+9,384,572	+41.2	7,977,294	20,801,190	+12,823,896	+160.7
Alaska	[3] 155,335	[3] 168,868	+13,533	+8.7	54,367	109,167	+54,800	+100.8
Total	22,947,604	32,345,709	+9,398,105	+40.9	8,031,661	20,910,357	+12,878,696	+160.3
Eastern States:								
Alabama		361	+361			233	+233	
Georgia	65	48	−17	−26.2	23	31	+8	+34.8
New York		26,406	+26,406			17,071	+17,071	
North Carolina	11,492	9,710	−1,782	−15.5	4,022	6,277	+2,255	+56.0
Pennsylvania	2,300	6,230	+3,930	+170.9	805	4,027	+3,222	+400.2
South Carolina	103	487	+384	+372.8	36	315	+279	+775.0
Tennessee	39,869	61,148	+21,279	+53.4	13,954	39,530	+25,576	+183.2
Virginia		103	+103			67	+67	
Total	53,829	104,493	+50,664	+94.1	18,840	67,551	+48,711	+258.6
Central States:								
Illinois	1,422	310	−1,112	−78.2	498	200	−298	−59.8
Michigan	125,926	529	−125,397	−99.6	44,074	342	−43,732	−99.2
Missouri		63,066	+63,066			40,770	+40,770	
Total	127,348	63,905	−63,443	−49.8	44,572	41,312	−3,260	−7.3
Philippine Islands	[3] 181,371	[3] 226,524	+45,153	+24.9	63,480	146,440	+82,960	+130.7
Puerto Rico	2	11	+9	+450.0	1	7	+6	+600.0
Total	181,373	226,535	+45,162	+24.9	63,481	146,447	+82,966	+130.7
Grand total	23,310,154	32,740,642	+9,430,488	+40.5	8,158,554	21,165,667	+13,007,113	+159.4

[1] Subject to slight revision. [2] Over 1,000 percent. [3] Refinery receipts.

SILVER MINING IN THE UNITED STATES

Silver production in the United States depends mainly on complex ores, as shown by the following table:

Silver produced in the United States, by sources, as reported by mines, 1922–33, and total fine ounces [1]

Year	Placers	Dry and siliceous ore	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total fine ounces
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
1922	0.10	46.78	16.95	27.38	2.74	1.09	4.96	61,207,989
1923	.08	39.28	20.87	28.62	3.09	1.92	6.14	70,355,674
1924	.08	31.82	25.50	29.43	.04	1.86	11.27	64,070,744
1925	.08	25.63	27.06	28.15	.27	1.45	17.36	66,710,080
1926	.08	21.71	27.27	24.85	.50	2.27	23.32	62,487,219
1927	.08	19.75	24.41	26.44	2.83	3.64	22.85	59,625,682
1928	.08	19.25	25.46	23.18	.20	3.82	28.01	57,872,443
1929	.07	18.25	29.49	19.23	2.59	4.66	25.71	60,860,011
1930	.09	18.32	28.53	18.40	.94	6.39	27.33	47,724,903
1931	.16	14.63	32.07	20.48	.02	9.35	23.29	29,856,628
1932	.28	17.29	22.78	21.53	.01	14.83	23.28	22,739,669
1933	.28	15.62	25.23	16.96	.31	15.00	26.60	23,130,596

[1] Philippine Islands and Puerto Rico excluded.

Alaska.—Silver production in Alaska in 1934 was a byproduct of lode and placer gold.

Arizona.—Copper ores in Arizona yielded 87, 90, 89, 89, and 88 percent, respectively, of the silver produced in Arizona in 1929, 1930, 1931, 1932, and 1933. In 1934, 77 percent of the silver came from copper ore from the Copper Queen Branch of the Phelps Dodge Corporation at Bisbee, the United Verde Extension mine at Clemenceau, and the New Cornelia mine at Ajo. Lead ore and siliceous ore from the reopened Tombstone properties, lead-zinc ore from the Montana mine at Ruby, and gold ore from the Hillside mine near Hillside contributed most of the remaining 13 percent of the State total.

California.—Most of the silver production in California has always been a byproduct of gold quartz mines.

Colorado.—From 1858 to 1934, inclusive, Colorado has produced 667,650,000 ounces of silver, which is 26,480,000 ounces more than the output (641,170,000 ounces) of its closest competitor, Montana, over the period 1862–1934. The production of silver in Colorado in 1934, in terms of recovered metal, was 3,475,661 fine ounces valued at $2,246,892, an increase of 1,289,521 ounces in quantity and $1,481,743 in value over 1933. In 1933 production increased 325,732 ounces in quantity and $240,514 in value over 1932. In 1934 Eagle County produced 1,942,284 ounces (55.88 percent of the State total); Mineral, 479,890 ounces (13.81 percent); San Juan, 303,012 ounces (8.72 percent); Pitkin, 121,105 ounces (3.48 percent); and Ouray, 109,853 ounces (3.16 percent). The largest increases were 479,890 ounces in Mineral County which had no production in 1933; 458,141 ounces in Eagle; 69,238 ounces in Clear Creek; 56,530 ounces in Ouray; 52,245 ounces in Pitkin; and 50,749 ounces in Lake. The only decrease among the important producing counties was 86,630 ounces in San Juan County. Copper ore in Colorado in 1934 yielded 1,927,335 ounces and dry and siliceous ores 1,435,352 ounces; the remainder of the silver output came from copper-lead, lead, and lead-zinc ore and placers.

Eastern and Central States.—A detailed account of silver production in these States is given in the chapter on Gold, Silver, Copper, Lead, and Zinc in the Eastern and Central States.

Idaho.—In Idaho, the second largest producer of lead in the United States, silver production was 7,410,000 ounces compared with 6,987,960 ounces in 1933. In 1934 as in 1933 Idaho continued as the largest silver-producing State in the United States. The Coeur d'Alene region in Shoshone County produced at least 7,050,000 ounces (95 percent of the State output). The Sunshine mine, east of Kellogg, produced 3,697,912 ounces in 1934 compared with 3,212,163 ounces in 1933. It is the largest producing silver mine in the United States, and it is predicted output can be raised to 5,000,000 ounces a year. Other large producers of silver, all in Coeur d'Alene region except as noted, were the Hecla, Bunker Hill & Sullivan (450,000 ounces less than in 1933), Morning, Crescent, Boise-Rochester (Elmore County), Page, Golconda, and Gold Hunter mines. In 1934 the Coeur d'Alene region continued to be the chief metal-producing area in Idaho, yielding 95 percent of the silver, 99 percent of the lead, all the zinc, and nearly all the copper. A fair average of the source of silver in Idaho is given by the 1933 figures, as follows:

	Fine ounces	Percent		Fine ounces	Percent
Dry gold ore	144, 976	2. 075	Copper-lead ore	3, 413, 255	48. 845
Dry gold and silver ore	3, 498	. 050	Lead-zinc ore	936, 980	13. 408
Dry silver ore	2, 269	. 032		6, 829, 974	97. 739
Dry and siliceous ore	150, 743	2. 157	Placers	7, 243	. 104
Copper ore	80	. 001	Total, 1933	6, 987, 960	100. 000
Lead ore	2, 479, 659	35. 485			

Montana.—The Anaconda Copper Mining Co. was as usual the chief producer of silver in Montana; its output in 1934 was nearly three fourths of the State total. Besides copper-silver and zinc-lead-silver mines at Butte, it operated its Flathead silver mine near Kila, which had been idle for several years. A labor strike from May to September closed the mines at Butte and the mills at Anaconda. The mines of the Anaconda Copper Mining Co. at Butte yielded nearly all the copper and most of the zinc and lead produced in the State. More than 62 percent of the total ore mined in the State came from mines at Butte, nearly all owned by the Anaconda Copper Mining Co. Of the total silver output of the State about 48 percent was from copper ore and 34 percent from zinc-lead ore; most of the remainder came from silver ore. The Granite-Bimetallic silver mine at Philipsburg, idle for several years, was operated in 1934. The Trout zinc-lead-silver mine at Philipsburg increased its output in 1934, as did the Jack Waite zinc-lead-silver mine in Sanders County. The source of silver in Montana has been as follows for 1929–33:

Source of silver in Montana, 1929–33

Year	Copper ore		Lead-zinc ore		Silver ore		Zinc ore		All other classes		Total	
	Fine ounces	*Percent*	*Fine ounces*	*Percent*	*Fine ounces*	*Percent*	*Fine ounces*	*Percent*	*Fine ounces*	*Percent*	*Fine ounces*	*Per cent*
1929	7, 289, 007	57. 32	2, 327, 493	18. 30	1, 151, 105	9. 05	1, 576, 332	12. 40	373, 040	2. 93	12, 716, 977	100
1930	4, 583, 827	64. 99	1, 261, 859	17. 89	640, 425	9. 08	449, 183	6. 37	117, 595	1. 67	7, 052, 889	100
1931	3, 710, 564	96. 89	26, 504	. 69	10, 371	. 27	6, 023	. 16	76, 375	1. 99	3, 829, 837	100
1932	1, 574, 071	93. 35	5, 464	. 32	6, 371	. 38	3, 025	. 18	97, 282	5. 77	1, 686, 213	100
1933	1, 613, 340	60. 64	790, 501	29. 71	52, 416	1. 97	9, 376	. 35	195, 067	7. 33	2, 660, 700	100

Nevada.—Silver production in Nevada increased from 1,148,621 ounces in 1933 to 2,850,000 in 1934—the largest production for the State since 1930 but much smaller than the 4,923,526 ounces in 1929 and far behind the 10,614,564 ounces in 1923. The increase in 1934 over 1933 was due to increased production of lead-zinc-silver ores at Pioche and Tybo. The reopening of the Tybo mines of the Treadwell Yukon Co., Ltd., in Nye County, which were idle throughout 1933, made Tybo one of the largest silver-producing districts in the State in 1934; the company was the largest individual producer of silver. The next largest source of silver was the lead-zinc-silver ore mined from the Pioche mines of the Combined Metals Reduction Co. at Pioche, followed by the dry silver ore mined by lessees from the Tonopah Mining Co. property in Nye County. Following in order of production were the Bristol Silver Mines Co., Jack Rabbit district, Lincoln County; Arizona Comstock Corporation, operating the Savage, Hale, and Norcross, Chollar, and Potosie claims, all within the city limits of Virginia City, Storey County; the Consolidated Chollar Gould & Savage Mining Co. at Gold Hill, Storey County; and the Tonopah Extension Mines, Inc., at Tonopah, Nye County.

Of interest was the production of 284,000 fine ounces of silver in 1934 from the famous old Comstock district in Storey County compared with the county output of 84,026 ounces in 1933. The 1934 output was the result of the reopening of some of the early-day mines of the Comstock Lode. A number of new mills were built, and several existing mills in the district were enlarged. The Comstock Lode from 1859 to 1902 produced $148,145,385 in gold (at $20.67 an ounce) and $204,653,040 in silver (at $1.2929 per ounce), exclusive of $6,272,953 in gold and $12,176,910 in silver (calculated partly at coinage value of $1.2929 and at average yearly prices) recovered from mill tailings between 1871 and 1902. The total production of the Comstock Lode from 1859 to 1933, inclusive, has been approximately $170,000,000 in gold and $227,000,000 in silver (coinage value).

New Mexico.—Mine production of recoverable silver in New Mexico was 1,061,775 ounces in 1934 compared with 1,181,580 ounces in 1933. The Pecos zinc-lead-copper-silver-gold mine in the Willow Creek district, San Miguel County, produced 51 percent of the total in 1934; the Central, Pinos Altos, and Steeple Rock districts, Grant County, produced nearly all of the 34 percent credited to Grant County; and the Mogollon district, Catron County, produced 11 percent. Lead-zinc ore from Grant and San Miguel Counties yielded 77.34 percent of the total silver; dry and siliceous ore chiefly from Catron and Grant Counties, 17.93 percent; copper ore chiefly from Grant County, 2.17 percent; copper-lead ore from Grant and Lincoln Counties, 2.06 percent; and lead ore chiefly from Grant County, 0.47 percent.

Oregon.—Oregon produced 46,560 ounces of silver in 1934, of which 37,837 ounces came from Baker County; over half of the silver production of Baker County was made by the Cornucopia Gold Mines, Inc., at Cornucopia.

South Dakota.—Silver is produced in South Dakota as a byproduct of the gold mines.

Texas.—Following the President's proclamation of December 21, 1933, establishing 64.64646464 cents as the price for newly mined silver the American Metal Co. of Texas on January 1, 1934 reopened its Presidio mine at Shafter, closed since June 30, 1930. Crude silver-copper ore was shipped to the El Paso smelter from the Hazel mine near Van Horn during the last 4 months of 1934.

Utah.—Utah, in a position during 1931, 1932, and 1933 to increase silver production because of large developed ore bodies but actually producing largely to provide employment, reacted to the increased silver price in 1934 according to the various judgments of the operators. The result was an output 1,442,220 ounces (25.44 percent) higher than in 1933 or 7,111,417 ounces in all. Silver recovered from siliceous ores, chiefly silver ores, increased 1,057,450 ounces, and silver from lead-zinc ore also increased materially, but silver recovered from lead ore decreased slightly. Lead-zinc ore yielded 52.94 percent of the State total; silver and siliceous ores, 27.56 percent; lead ore, 14.15 percent; and copper ore, 5.28 percent. The output of silver in the Bingham district increased 659,878 ounces compared with 1933. The gain was due chiefly to increases at the Lark, Utah Apex, Utah Delaware, and Utah Copper properties. The output of silver in the Park City region increased 316,564 ounces due to reopening of the Park City Consolidated mine; production decreased from the Silver King Coalition mine. The output of silver in the Tintic district increased 268,104 ounces; increases at the Plutus, Centennial-Beck, and Chief Consolidated properties more than offset the decreases at the Tintic Standard and Eureka Standard. There was also a substantial increase in silver from the Ophir-Rush Valley section in Tooele County. The largest producer of silver in Utah in 1934 was the United States Smelting, Refining & Mining Co.; it was followed by the Silver King Coalition and Tintic Standard properties. These three properties, each with a production of over 1,000,000 ounces, yielded 61.55 percent of the output of silver in the State. Utah retained second place after Idaho as a silver producer.

Washington.—The production of silver in Washington increased 25,600 ounces over 1933. Most of the increase came from siliceous gold-silver ore from mines at Republic, Ferry County, and from siliceous silver ore and lead ore from mines in Stevens County. The Knob Hill mine at Republic was the largest producer of silver in Washington in 1934, followed by the Old Dominion mine near Colville and the Daisy mine near Daisy, both in Stevens County, and the Blaine Republic and Mountain Lion properties at Republic.

COPPER

By J. W. Furness, Elmer W. Pehrson, and H. M. Meyer [1]

SUMMARY OUTLINE

The copper industry in the United States in 1934 showed some improvement over 1933, but 1934 must be considered as a subnormal year compared to the period from 1922 to 1931. Domestic mine and smelter production was higher than in 1933, although still in the range of the lowest levels in more than 30 years. The average price for the year represented a substantial advance. Owing to continued drastic curtailment of production and a large increase in exports, stocks of refined copper at primary refineries were drawn upon more freely in 1934 and were reduced from 406,500 tons at the beginning of 1934 to 284,500 tons at the close of the year. Imports as well as exports increased materially, but the export surplus was considerably larger than in 1933. Actual consumption of all copper was higher in 1934 than in 1933, but the increase was supplied by secondary metal and withdrawals from consumers' stocks. Apparent consumption of primary copper decreased in 1934. Figure 9 shows trends in the domestic copper industry since 1910.

Production in foreign countries during 1934 increased materially over that in the previous year and was 15 percent above the 1929 output. Notable increases were recorded in the production of Chile, Africa, and Canada. Although foreign consumption of copper exceeded all previous records the increased production abroad and the large increase in exports from the United States brought selling pressure on the London market, which resulted in a decline in the London price. This led to a production-control agreement among the principal copper producers outside the United States early in 1935.

[1] Figures on imports and exports in the United States compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

The increase in foreign production in 1934 and the lack of refining facilities abroad necessitated wider use of United States refining capacity. There were large increases in mports of blister from Mexico, Chile, Yugoslavia, Peru, and Canada and of ores and con-

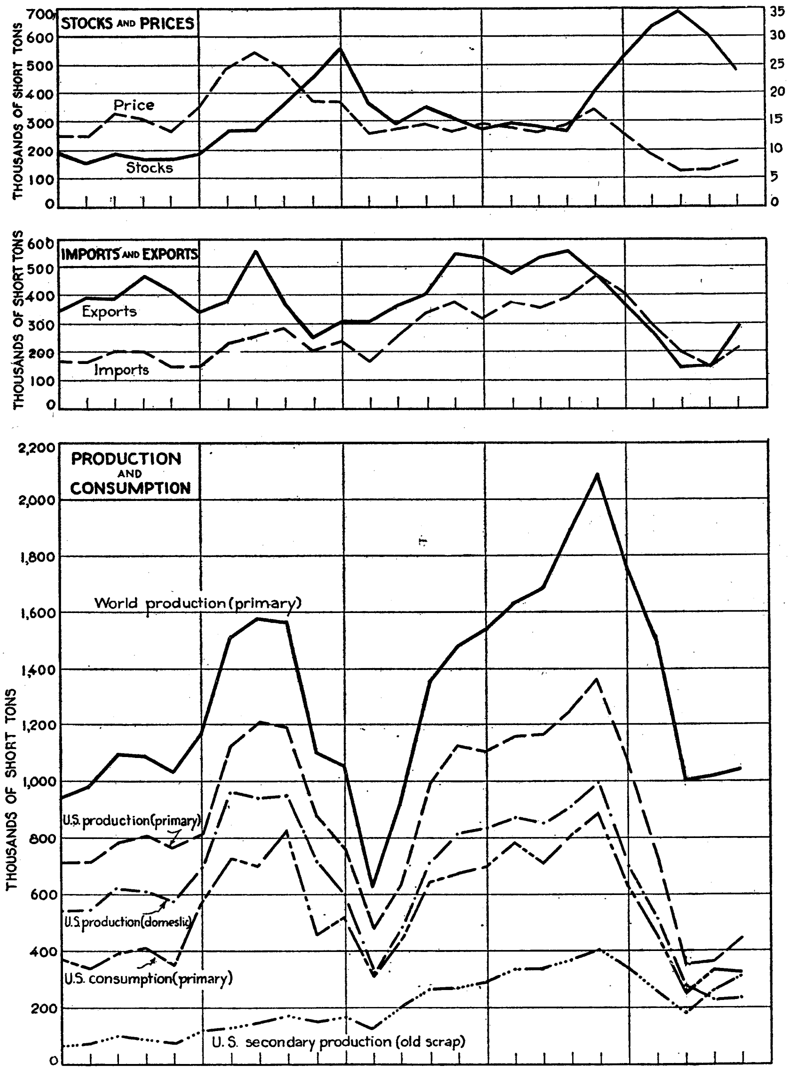

FIGURE 9.—Salient features of copper industry in the United States, 1910–34.

centrates from Canada and Chile. Shipments of blister from Africa were large, although lower than in 1933. Additional decrease from this source may be expected as a result of the completion of a new refinery in Rhodesia early in 1935. Imports from Yugoslavia represented shipments from the Bor mine. This blister contained considerable gold, and its treatment in the United States was commercially possible owing to the increase in the domestic price of gold. Shipments of copper in the form of ore and concentrates from Cuba, which enters this country free of duty under the Platt Amendment amounted to nearly 16,000,000 pounds in 1934. These large increases in receipts of foreign raw materials resulted in an unprecedented condition in the domestic refining industry wherein the production of refined copper from foreign sources was almost as large as the output from domestic ores. The proportion was the highest ever shown by statistical record.

The year 1934 also developed a marked increase in exports of copper over 1933. Exports were not covered under the code and therefore were unrestricted. Sales quotas allotted the domestic producers in some cases would have necessitated a reduction in output which in turn would have increased cost of production materially. To avoid this output was maintained or increased, and the excess over quota allowances was exported. This was done notwithstanding the differential in price between domestic and foreign markets.

The average domestic quoted price for electrolytic copper f. o. b. refinery was 7.9 cents a pound in January 1934. In April, in anticipation of approval of the copper code, which became effective April 26, 1934, the price averaged 8.2 cents. In June it was advanced to 8.6 cents, and from June 14 until the end of the year the average price of copper produced and sold under conditions laid down by the code was 9 cents a pound, equivalent to 8.775 cents f. o. b. refinery. Copper sold under the code was known as "Blue Eagle copper." [2]

From the time the Copper Code first was operative until September 1934 actual consumption (not sales) of new copper exceeded the total sales quota of 30,750 tons per month. In September sales fell below the "book" of 30,750 tons, and at a meeting of the United States Copper Association on September 27, 1934, in New York the primary producers agreed to waive their sales quotas to insure successful operation of the code. The agreement to set aside primary quotas was for the period September 15 through October 31, during which time all sales were to be allocated to producers of secondary, custom, and byproduct copper (secondary producers had a quota of 10,250 tons a month revised in June 1934 from the original total of 9,500 tons) until their quotas had been filled, and only after that were sales to be allocated to primary producers. After the meeting, E. T. Stannard, president of the association, issued a statement quoted in part below:

> The sales plan of the copper code provides for a total quota of 30,750 tons per month (known as the "book"). Actual consumption (not sales) of new copper for the first 8 months of the year averaged about 38,000 tons per month and estimates for September indicate just under 30,000 tons for that month.
>
> Actual sales have exceeded the total requirements of the book up to September 1, but in September have been inadequate to take care of the book for that month. * * *
>
> As a result of the meeting, the principle was approved that production of new copper should be kept up to the highest point possible in relation to consumption in order to provide for as much employment as possible, but that if future consumption falls below the book of 30,750 tons a month, steps be taken to reduce production so that production, averaged over a reasonable period, shall be kept in balance with consumption. * * *

Sales of copper continued to run below total sales quotas under the code so that at a meeting on October 31 it was found necessary to extend the suspension of sales allocations to primary producers through

[2] Minerals Yearbook, 1934, p. 54.

November. It was reported at that time that sales since September 15 had been large enough to more than cover the intake of secondary producers. With current business in copper showing scarcely any improvement, late in November primary producers again agreed to set aside their quotas, this time for 2 months, December and January. Unofficially the secondary producers were requested to restrict their operations by 25 percent, which they consented to do for the 2-month period. This restriction of operations brought the sales quotas of secondary producers to less than 7,700 tons a month.

In December the Copper Code Authority announced revisions in monthly sales quotas of secondary producers as follows:

	July-December 1934 quotas (short tons)	*January-June 1935 quotas (short tons)*
American Metal Co	3, 493	3, 350
Nichols Copper Co	2, 209	2, 477
American Smelting & Refining Co	2, 209	2, 209
Anaconda Copper Mining Co	1, 105	1, 030
Lewin Metals Corporation	854	804
Nassau Smelting & Refining Works	380	380
	10, 250	10, 250

An interesting feature of the code was that all companies with production capacity were given sales quotas; thus production was maintained in part by high-cost as well as low-cost producers.

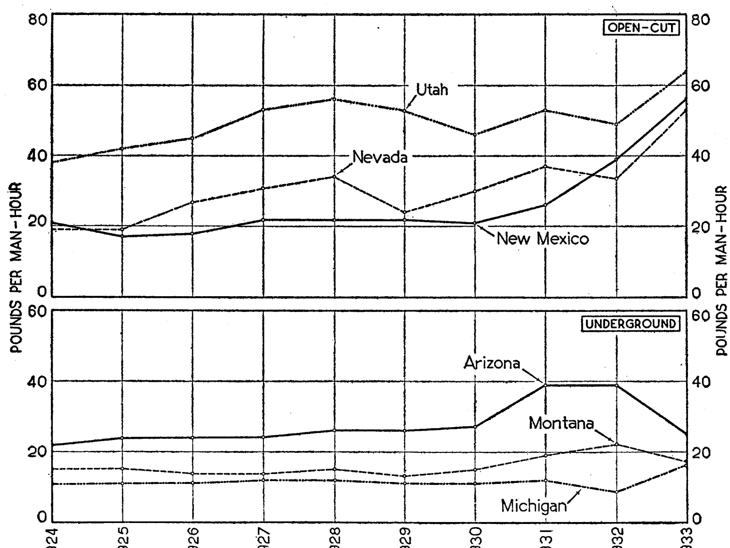

FIGURE 10.—Output of copper per man-hour of employment in opencut and underground mines, 1924–33. Compiled by G. B. Holderer, consulting mining engineer, sectional economic research, Federal Emergency Relief Administration, from statistics of the Bureau of Mines.

The tendency toward selective mining during the depression, as evidenced by the steady increase in the average tenor of copper ores mined, is a factor that will have an important bearing on the future of the copper-mining industry in the United States, inasmuch as it tends to reduce the average copper content of domestic reserves. Considering the decade 1924 to 1933, inclusive, the average tenor of copper ore treated in the United States was 1.49 percent. As can be noted from the table on page 57 the average from 1927 to 1929 was 1.41 percent. During these years a high rate of production as well as high prices were maintained, and conditions led to the mining of ores of a lower average grade than had been treated previously. These conditions were reversed from 1930 to 1934 by curtailment of demand and production. In this period the grade of ore mined increased to an average of 2.11 percent in 1933, the advance being due to the practice of selective mining, not only in single deposits but in entire districts as well.

Selective mining has been an important factor in increasing the productivity of labor and thus has contributed to reducing the cost of producing copper, but this effect has been more pronounced in opencut mining than in underground mining, as can be seen from figure 10, which shows the copper mined per man-hour in the principal copper-producing States grouped according to whether the method of mining is predominantly opencut or underground. Since the cost of labor is such an important part of total costs, the chart also indicates roughly the relative costs of producing copper in the various States.

The following table shows world production and the salient domestic statistics on copper for the 5-year period 1925–29, and for 1931, 1932, 1933, and 1934.

World production and salient domestic statistics of copper, 1925–29 and 1931–34

[All tonnage figures in short tons]

	Average, 1925–29	1931	1932	1933	1934
World smelter production, new copper	1,761,000	1,536,000	1,045,000	1,159,000	[1] 1,420,000
United States production:					
New copper—					
From domestic ores, as reported by—					
Mines	885,826	528,875	238,111	190,643	[2] 236,950
Ore produced:					
Copper ore	59,505,871	[3] 34,050,961	[3] 12,320,194	[3] 8,387,612	(4)
Average yield of copper, percent	1.44	1.50	1.83	2.11	(4)
Smelters	892,730	521,356	272,005	225,000	244,227
Percent of world total	51	34	26	19	17
Refineries	890,767	537,303	222,539	240,669	233,029
From foreign ores, matte, etc., refinery reports	317,287	213,418	117,895	130,120	212,331
Total new refined, domestic and foreign	1,208,054	750,721	340,434	370,789	445,360
Secondary copper recovered from old scrap only	347,512	261,300	180,980	260,300	310,900
Copper content of copper sulphate produced by refiners	4,601	4,492	3,173	3,240	3,167
Total production, new and old and domestic and foreign	1,560,167	1,016,513	524,587	634,329	759,427
Imports (unmanufactured)	391,212	292,946	195,996	143,717	[5] 213,286
Refined	59,236	87,225	83,897	5,432	[5] 27,417
Exports of metallic copper [6]	522,616	278,787	147,678	151,913	296,359
Refined (ingots, bars, rods, etc.)	482,868	232,114	125,029	132,371	272,138
Stocks at end of year	307,200	636,300	691,000	600,500	479,000
Refined copper	86,100	462,300	502,000	406,500	284,500
Blister and materials in solution	221,100	174,000	189,000	194,000	194,500
Withdrawals from total supply on domestic account:					
Total new copper	778,123	451,032	259,602	339,350	322,638
Total new and old copper	1,288,700	798,000	508,000	677,500	700,000
Price, average cents per pound	14.7	9.1	6.3	6.4	8.0

[1] Approximate.
[2] Subject to revision.
[3] Includes old tailings.
[4] Figures not yet available.
[5] Data for 1934 include copper imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given for previous years.
[6] Total exports of copper, exclusive of ore, concentrates, composition metal, and unrefined copper. Exclusive also of "Other manufactures of copper" for which figures of quantity are not recorded.

Mineral policy committee.—The following paragraphs are quoted from the report of the mineral policy committee to the National Resources Board:

The committee is not prepared at this time to recommend either to the copper producers or to the public a copper cartel following the European plan, with full control of price, output, capacity, and other elements of supply. If such a system of control is to come in the United States, time must be allowed for experiment with less ambitious schemes and for development of a larger body of experience both in the technique of industry operation and of public supervision, under the very different conditions of American life.

But the committee would urge leaving the way open for experiment in these lines under public supervision and with provisions that will at once safeguard the rights of labor and clarify its responsibilities. We would urge that the problem of economic stability in the copper industry is essentially international and that joint action by American producers and foreign producers may often be needed. * * *.

In addition, the committee offers the following recommendations:

(1) Full and complete statistics should be provided covering all factors of supply and demand, including consumption and consumers' stocks as well as production and producers' stocks, and including scrap as well as virgin metal. Such market information should be deposited with one of the permanent Government mineral fact-finding agencies. * * *.

(2) Forecasts of consumption should be made by a public agency in collaboration with representatives of both producers and consumers. * * *.

(3) Some limitation should be imposed on the piling up of surplus stock. It is assumed that the emergency control under the present N. R. A. code will in time reduce stocks to manageable proportions. Thereafter we recommend limitation of stock accumulations by joint action of the trade, under supervision of public authority. If such joint action by the industry is forbidden by the antitrust laws, we recommend consideration of such legislation as will authorize it under the necessary public supervision.

Tariff.—The 4-cent excise tax on imports of copper was extended to June 30, 1937, by legislative action at the close of June 1935.

DOMESTIC PRODUCTION

Considering certain qualifying factors, statistics on the production of copper may be obtained by taking mine, smelter, or refinery production. If mine output is considered, data on secondary copper would not appear. If smelters are considered, only a part of secondary copper would be accounted for. If refinery figures are taken, part of the blister copper, as well as copper sulphate, would not be included. For these and other reasons it is desirable to maintain three sets of statistics.

Copper produced from domestic ores, as reported by mines, smelters, and refineries, 1930–34, in pounds

Year	Mine	Smelter	Refinery
1930	1,410,147,374	1,394,389,327	1,391,224,205
1931	1,057,749,350	1,042,711,178	1,074,606,041
1932	476,221,076	544,009,948	445,077,874
1933	381,285,194	449,999,143	481,338,031
1934	[1] 473,900,000	488,454,107	466,058,360

[1] Subject to revision.

PRIMARY COPPER

Smelter production.—The copper output of United States smelters from domestic ores in 1934 was 488,454,107 pounds, an increase of 38,454,964 pounds (9 percent) over the output in 1933. This production was 17 percent of the world copper output, though it had averaged 51 percent from 1925 to 1929. The origin of smelter production by States is shown below:

Copper produced in the United States from domestic ores, 1930–34

[Smelter output, in pounds fine]

State	1930	1931	1932	1933	1934
Alabama					10,972
Alaska	36,380,038	23,233,034	13,297,443	1,575,936	130,284
Arizona	570,897,080	400,310,634	201,136,276	122,697,035	168,408,450
California	26,262,447	8,344,901	5,514,045	632,049	232,845
Colorado	12,943,857	9,028,517	8,976,169	8,882,397	13,046,759
Idaho	2,713,681	1,626,541	662,957	2,183,284	1,717,895
Michigan	142,985,522	105,222,177	63,898,656	72,340,852	51,681,901
Missouri	2,198			181,703	46,276
Montana	198,795,883	173,910,101	97,918,141	94,262,651	67,005,217
Nevada	87,475,019	71,233,352	32,616,050	42,507,400	41,922,506
New Mexico	74,187,966	66,776,267	32,914,883	24,948,272	26,994,219
North Carolina	(1)	(1)	(1)	(1)	(1)
Oklahoma					10,723
Oregon	229,753	9,332	36,890	9,301	41,422
Pennsylvania	3,061,174	843,956	(1)	(1)	(1)
South Carolina				408	421
Tennessee	(1)	(1)	(1)	(1)	(1)
Texas	165,731	514	8,588	2,137	32,956
Utah	205,769,698	161,023,199	76,402,502	65,655,914	96,223,463
Vermont	(1)				
Virginia					384
Washington	1,404,893	71,426	2,521	87,199	33,393
Wyoming	29,356	9,545	607	46	3,390
Undistributed	31,085,031	21,067,682	10,624,220	14,032,559	20,910,631
	1,394,389,327	1,042,711,178	544,009,948	449,999,143	488,454,107

[1] Included under "Undistributed." Bureau of Mines not at liberty to publish figures.

The figures for smelter production in 1934 are based on confidential returns from all smelters handling copper-bearing materials produced in the United States. For Michigan the sum of furnace-refined copper and copper cast into anodes for electrolytic refining is included. The figures for blister represent the fine-copper content. Some casting and electrolytic copper produced direct from ore or matte is included in the smelter production. Metallic and cement copper recovered by leaching also are included in smelter production.

The precise quantity in pounds of copper produced by smelters in the United States and the value are shown by years for 1845–1930 in the copper chapter of Mineral Resources of the United States, 1930.

The data are summarized for comparison with those of 1931, 1932, 1933, and 1934 in the following table:

Copper produced (smelter output) in the United States, 1845–1934

[Values rounded]

Period	Quantity		Total value
	Total (short tons)	Average per year (short tons)	
1845–80	363, 996	10, 111	$175, 490, 000
1881–1900	2, 994, 764	149, 738	796, 355, 000
1901–10	4, 281, 716	428, 172	1, 273, 911, 000
1911–20	7, 160, 559	716, 056	2, 850, 306, 000
1921–30	7, 423, 403	742, 340	2, 117, 235, 000
1931	521, 356	521, 356	94, 887, 000
1932	272, 005	272, 005	34, 273, 000
1933	225, 000	225, 000	28, 800, 000
1934	244, 227	244, 227	39, 076, 000
1845–1934	23, 487, 026	260, 967	7, 410, 333, 000

Mine production.—The figures of mine production are based on reports furnished to the Bureau of Mines by all domestic mines producing copper. Details of the method of collecting the statistics and reasons for the discrepancy between mine, smelter, and refinery production figures are given in the copper chapter of Mineral Resources of the United States, 1930.

Mine production is more accurate than either refinery or smelter production for showing the distribution of domestic production by States and districts. It also indicates the ore production by calendar years more exactly because additional time is required for smelting and refining. Mine production in 1934 was 473,900,000 pounds, an increase of 24 percent over that in 1933 but still 73 percent below the average for 1925–29.

Production by States and districts.—The following tables show mine and smelter production by States for 1933 and 1934 and by districts for 1929–34. In 1934 Arizona, Utah, Montana, and Michigan led in the production, with 78 percent of the smelter output. If the production of Nevada and New Mexico is added to the output of these States 93 percent of the country's output is represented. Among the copper-producing districts Bingham ranked first in 1934, Butte second, and Lake Superior third.

From 1845 through 1934 Arizona, Montana, Michigan, and Utah, in the order named, were the principal producers, contributing 84 percent of the total output. Butte, Lake Superior, Bingham, and Bisbee, in the order named, were the principal districts.

Details of production by districts and companies in 1934 are available in other chapters of this volume dealing with production of gold, silver, copper, lead, and zinc in the various States.

Copper produced in the United States, according to smelter and mine returns, by States, 1933, 1934, and 1845–1934, in short tons

	1933		1934			1845–1934	
	Smelter returns	Mine returns	Smelter returns		Mine returns [1]	Smelter output	
			Percent of total	Quantity		Total quantity	Percent of total
Alabama	-------	-------	-------	5	6	(2)	(2)
Alaska	788	15	0.02	65	[1] 50	616,106	2.62
Arizona	61,349	57,021	34.48	84,204	[1] 88,533	7,689,210	32.74
California	316	495	.05	116	285	547,534	2.33
Colorado	4,441	4,834	2.67	6,524	5,647	196,116	.83
Idaho	1,092	781	.35	859	[1] 765	74,202	.32
Michigan	36,170	23,427	10.58	25,841	24,108	4,337,713	18.47
Missouri	91	-------	.01	23	23	(2)	(2)
Montana	47,131	32,738	13.72	33,503	[1] 31,625	5,318,165	22.64
Nevada	21,254	14,245	8.58	20,961	[1] 20,875	998,620	4.25
New Mexico	12,474	13,473	5.53	13,497	11,815	769,419	3.28
North Carolina	(3)	(3)	(3)	(3)	(3)	(2)	(2)
Oklahoma	-------	-------	-------	5	-------	(2)	(2)
Oregon	5	6	.01	21	19	10,354	.04
Pennsylvania	(3)	(3)	(3)	(3)	(3)	(2)	(2)
South Carolina	(4)	-------	-------	(4)	(4)	(2)	(2)
Tennessee	(3)	(3)	(3)	(3)	(3)	[5] 259,508	[5] 1.11
Texas	1	1	.01	16	15	(2)	(2)
Utah	32,828	36,791	19.70	48,112	43,012	2,477,190	10.55
Virginia	-------	-------	-------	(4)	(4)	(2)	(2)
Washington	44	3	.01	17	7	14,269	.06
Wyoming	(4)	-------	-------	2	2	15,862	.07
Undistributed	7,016	6,813	4.28	10,456	10,161	[6] 162,758	.69
	225,000	190,643	100.00	244,227	[1] 236,950	23,487,026	100.00

[1] Subject to revision.
[2] Included under "Undistributed." Figures not separately recorded.
[3] Included under "Undistributed." Bureau of Mines not at liberty to publish figures.
[4] Less than 1 ton.
[5] Approximate production through 1928. Figures for 1929–34 are confidential and are included under "Undistributed."
[6] Includes Tennessee for 1929-34.

Mine production of copper in the principal districts,[1] 1929–34, in terms of recovered copper, in short tons

District or region	State	1929	1930	1931	1932	1933	1934
Bingham	Utah	155,946	87,535	73,853	31,234	35,818	41,793
Butte	Montana	148,158	97,736	92,181	42,300	32,618	[2] 31,427
Lake Superior	Michigan	93,201	84,691	59,030	27,198	23,427	24,108
Yavapai County (mostly Jerome district).	Arizona	104,086	58,845	22,288	17,904	16,629	(3)
Ely (Robinson)	Nevada	65,378	52,693	35,667	15,442	14,094	(3)
Central (including Santa Rita)	New Mexico	43,723	28,622	28,159	13,256	12,571	10,895
Pioneer	Arizona	19,558	16,193	14,052	11,026	10,915	(3)
Battle Mountain	Colorado	1,570	2,925	3,324	2,810	4,082	4,910
Ray (Mineral Creek)	Arizona	33,144	18,059	12,219	7,202	1,376	(3)
Willow Creek	New Mexico	1,321	719	548	510	877	867
Tintic	Utah	1,583	1,431	784	473	428	573
Shasta County	California	3,017	1,981	155	148	428	194
Park City	Utah	1,262	839	409	451	366	278
Globe-Miami	Arizona	95,798	79,060	63,222	14,224	129	(3)
Banner	do	2,520	3,775	1,303	124	20	(3)
Lordsburg	New Mexico	2,124	2,429	1,996	429	11	14
Bonanza	Colorado	1,334	617	3	-------	2	-------
Plumas County	California	12,465	9,765	6,227	522	(4)	(4)
Alder Creek	Idaho	1,412	561	-------	-------	-------	(3)
Copper River [5]	Alaska	(6)	(6)	(6)	[7] 4,369	(8)	(3)
Prince William Sound [5]	do	(6)	(6)	(6)	-------	(8)	(3)
Ajo [5]	Arizona	35,502	25,102	(6)	(6)	-------	(3)
Bisbee (Warren)[5]	do	93,065	63,950	47,664	23,702	(6)	(3)
Morenci-Metcalf [5]	do	28,391	21,572	(6)	11,931	4	(3)
Silver Bell [5]	do	1,192	113	(6)	-------	-------	(3)
Battle Mountain [5]	Nevada	1,216	653	70	(6)	30	(3)
Jack Rabbit [5]	do	1,319	998	(6)	(6)	(6)	(3)
Yerington [5]	do	1,635	(6)	(6)	-------	16	(3)
Swain County [5]	North Carolina	(6)	(6)	(6)	(6)	(6)	(6)
Lebanon (Cornwall mine)[5]	Pennsylvania	1,727	1,430	(6)	(6)	(6)	(6)
Ducktown [5]	Tennessee	(6)	(6)	(6)	(6)	(6)	(6)

[1] Districts producing 1,000 short tons or more in any year of the period, 1929–34.
[2] Subject to revision.
[3] Data not available.
[4] Less than 1 ton.
[5] Not listed in order of output.
[6] Bureau of Mines not at liberty to publish figures.
[7] Includes a small quantity produced elsewhere in State.
[8] Total for Alaska was 15 tons; data by districts not available.

Quantity and estimated recoverable content of copper-bearing ores.—The following tables show the quantity and the estimated recoverable copper content of the ore produced by United States mines in 1932 and 1933. Of the total copper produced from copper ores in the United States in 1933, 69 percent was obtained from ores concentrated before smelting and 31 percent from direct smelting ore. In 1932 the figures were 74 percent from concentrated ore, 24 percent from direct smelting ore, and 2 percent from leaching.

Close agreement between the output as reported by the smelters and the recoverable quantity as reported by the mines indicates that the estimated recoverable tenor is very close to the actual recovery. Classification of some of the complex western ores is difficult and more or less arbitrary. Under copper ores are grouped not only those that contain 2.5 percent or more copper but also those that contain less than this percentage if they are valuable chiefly for copper. Under copper-lead and copper-lead-zinc ores are classed complex ores in which copper is a valuable constituent. Mines report considerable copper from ores mined primarily for other metals. These include siliceous gold and silver ores, lead and zinc ores, and pyritic sulphur ores.

Copper ore, old tailings, etc., sold or treated in the United States in 1932–33, with copper, gold, and silver content in terms of recovered metals

State	Ore, old tailings, etc., sold or treated (short tons)	Copper produced		Gold produced (fine ounces)	Silver produced (fine ounces)	Value of gold and silver per ton of ore
		Pounds	Percent			
1932						
Alaska	56,900	8,738,500	7.68		81,150	$0.40
Arizona	4,343,070	[1] 181,408,411	2.09	38,631.14	[1] 1,862,366	.30
California	[2] 78,031	1,353,505	.87	1,561.28	28,726	.52
Colorado	49,404	5,624,200	5.69	2,402.30	1,103,829	7.31
Idaho	12	3,367	14.03	10.53	34	19.00
Michigan	1,142,775	54,396,108	2.38		71,408	[3] .08
Montana	668,679	[4] 75,311,845	5.63	8,657.76	1,574,071	.93
Nevada	1,357,464	31,383,875	1.16	13,459.14	42,553	.21
New Mexico	1,184,528	24,005,050	1.01	2,718.65	58,820	.06
Oregon	176	30,948	8.79	35.00	2,170	7.59
Texas	104	7,000	3.37	.68	826	2.38
Utah	3,196,677	[5] 56,800,128	.89	31,066.35	324,693	.23
Eastern States	[6] 242,374	10,872,200	2.24	371.27	30,130	.07
	[6] 12,320,194	449,935,137	1.83	98,914.10	5,180,776	.28
1933						
Arizona	888,508	[1] 112,975,691	6.36	[1] 47,410.62	[1] 2,113,721	2.20
California	[2] 38,176	[7] 761,003	1.00	1,153.95	5,015	.82
Colorado	91,133	8,177,020	4.49	3,862.60	1,482,975	6.78
Idaho	17	3,407	10.02	12.53	80	20.47
Michigan	697,158	46,853,130	3.36		[8] 125,926	[3] .13
Montana	491,893	[4] 55,820,562	5.67	4,578.93	1,613,340	1.39
Nevada	1,197,498	28,226,322	1.18	11,545.65	69,605	.27
New Mexico	1,100,707	22,193,206	1.01	1,121.71	18,657	.03
Texas	45	2,000	2.22		63	[3] .49
Utah	3,524,073	[5] 65,565,215	.93	35,527.84	353,154	.29
Eastern States	[6] 358,404	13,626,320	1.90	623.99	53,569	.10
	[6] 8,387,612	354,203,876	2.11	105,837.82	5,836,105	.57

[1] Excludes 957,136 pounds of copper in 1932 and 836,942 pounds in 1933 recovered from precipitates, but includes a small quantity of silver in 1932 and small quantities of gold and silver in 1933 from precipitates.
[2] Includes 43,278 tons of pyrites in 1932 and 37,413 tons of pyrites in 1933 roasted for the manufacture of sulphuric acid (residue leached).
[3] Calculated only on ore that yielded silver.
[4] Excludes 9,474,300 pounds of copper in 1932 and 9,167,018 pounds in 1933 recovered from precipitates.
[5] Excludes 4,490,379 pounds of copper in 1932 and 4,107,381 pounds in 1933 recovered from precipitates.
[6] Includes copper concentrates from pyritiferous magnetite ore from Pennsylvania.
[7] Includes 257,537 pounds of copper from copper concentrates produced in 1930 but not marketed until 1933; excludes 167,036 pounds of copper recovered from precipitates.
[8] Includes a small quantity of silver from old tailings treated for the recovery of gold and silver.

Copper ore, old tailings, etc., concentrated in the United States in 1932–33, with content in terms of recovered copper

State	Ore, old tailings, etc., concentrated (short tons)	Concentrates produced (short tons)	Copper produced (pounds)	Percent of copper from ore, etc.
1932				
Alaska	56, 078	9, 143	8, 043, 572	7. 17
Arizona	3, 303, 109	[1] 199, 857	[1] 83, 123, 287	1. 26
California	34, 741	2, 114	1, 043, 257	1. 50
Michigan	1, 142, 775	39, 877	54, 396, 108	2. 38
Montana	631, 460	138, 924	72, 385, 248	5. 73
Nevada	1, 351, 695	58, 626	30, 554, 313	1. 13
New Mexico	1, 165, 370	34, 145	23, 029, 000	. 99
Utah	3, 169, 411	88, 712	55, 618, 143	. 88
Eastern States	[2] 110, 110	11, 369	3, 388, 900	[3] 1. 54
	10, 964, 749	582, 767	331, 581, 828	1. 51
1933				
Arizona	307, 551	[1] 85, 459	[1] 23, 088, 980	3. 75
California	8	[4] 609	[4] 258, 985	([5])
Michigan	697, 158	34, 500	46, 853, 130	3. 36
Montana	479, 462	108, 645	54, 135, 827	5. 65
Nevada	1, 193, 348	46, 862	27, 883, 364	1. 17
New Mexico	1, 100, 390	31, 956	22, 166, 000	1. 01
Utah	3, 521, 425	99, 458	65, 303, 242	. 93
Eastern States	[2] 176, 646	11, 596	4, 204, 240	[3] 1. 19
	7, 475, 988	419, 085	243, 893, 768	1. 63

[1] Includes very small quantities of copper concentrates and copper from ore treated at gold and silver mills in 1932 and small quantities of copper concentrates and copper from siliceous gold ore in 1933.
[2] There were 69,811 tons of pyritiferous magnetite ore yielding 784 tons of copper concentrates in 1932 and 347,290 tons yielding 2,158 tons in 1933, not included with copper ore.
[3] Obtained by using copper concentrates for Pennsylvania and copper ore for other Eastern States.
[4] Includes concentrates containing 257,537 pounds of recoverable copper produced in 1930 but not marketed until 1933.
[5] Not available.

Copper ore leached and smelted in the United States in 1932–33, with content in terms of recovered copper

State	Ore leached			Ore smelted		
	Short tons	Copper produced (pounds)	Percent of copper	Short tons	Copper produced (pounds)	Percent of copper
1932						
Alaska				822	694, 928	42. 27
Arizona	537, 929	11, 061, 682	1. 03	501, 544	86, 404, 049	8. 61
California	[1] 30, 087	([2])	([2])	12	1, 838	7. 66
Colorado				49, 404	5, 624, 200	5. 69
Idaho				12	3, 367	14. 03
Montana				22, 876	2, 734, 256	5. 98
Nevada				5, 769	829, 562	7. 19
New Mexico				19, 158	976, 050	2. 55
Oregon				176	30, 948	8. 79
Texas				104	7, 000	3. 37
Utah				27, 266	1, 181, 985	2. 17
Eastern States				131, 480	7, 483, 300	2. 85
	568, 016	[3] 11, 061, 682	[3] 1. 03	758, 623	105, 971, 483	6. 98
1933						
Arizona				580, 951	89, 918, 982	7. 74
California	([4])	([2])	([2])	755	78, 674	5. 21
Colorado				91, 133	8, 177, 020	4. 49
Idaho				17	3, 407	10. 02
Montana				12, 431	1, 684, 735	6. 78
Nevada				4, 150	342, 958	4. 13
New Mexico				317	27, 206	4. 29
Texas				45	2, 000	2. 22
Utah				2, 634	257, 422	4. 89
Eastern States				179, 600	9, 422, 080	2. 62
	([4])	([2])	([2])	872, 033	109, 914, 484	6. 30

[1] Residue from pyrites roasted for manufacture of sulphuric acid.
[2] Bureau of Mines not at liberty to publish figures.
[3] Exclusive of California, figures for which the Bureau of Mines is not at liberty to publish.
[4] Residue from 37,413 tons of pyrites roasted for manufacture of sulphuric acid was leached.

Copper-lead ores sold or treated in the United States in 1932–33, with content in terms of recovered copper

State	Copper-lead ores (short tons)	Copper produced (pounds)	Percent of copper
1932			
Arizona	18	791	2.20
Colorado	25	1,400	2.80
Idaho	165,490	641,245	.19
Montana	104	5,770	2.77
Nevada	484	22,360	2.31
New Mexico	977	49,700	2.54
Utah	8	934	5.84
	167,106	722,200	.22
1933			
California	8	710	4.44
Colorado	66	2,900	2.20
Idaho	121,769	875,539	.36
Montana	60	6,250	5.21
Nevada	2,885	151,893	2.63
New Mexico	1,419	91,886	3.24
	126,207	1,129,178	.45

Ores, old tailings, etc., classed as copper-bearing (copper and copper-lead) sold or treated in the United States in 1932–33, with copper content, and copper produced from all sources, in terms of recovered copper

State	Copper from copper and copper-lead ores, old tailings, etc.			Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds)
	Ores, old tailings, etc., sold or treated (short tons)	Copper produced (pounds)	Percent of copper	
1932				
Alaska	56,900	8,738,500	7.68	8,738,500
Arizona	4,343,088	181,409,202	2.09	182,491,825
California	78,031	1,353,505	.87	1,417,876
Colorado [1]	49,429	5,625,600	5.69	7,398,000
Idaho	165,502	644,612	.19	1,143,381
Michigan	1,142,775	54,396,108	2.38	54,396,108
Montana [2]	668,783	75,317,615	5.63	84,847,349
Nevada	1,357,948	31,406,235	1.16	31,487,606
New Mexico [3]	1,185,505	24,054,750	1.01	28,419,000
Oregon	176	30,948	8.79	32,199
Texas	104	7,000	3.37	7,000
Utah [4]	3,196,685	56,801,062	.89	64,964,111
Washington				5,524
Wyoming				397
Eastern States	[5] 242,374	10,872,200	2.24	10,872,200
	[5] 12,487,300	450,657,337	1.80	476,221,076
1933				
Alaska				29,000
Arizona	888,508	112,975,691	6.36	114,041,781
California	38,184	761,713	1.00	990,380
Colorado [1]	91,199	8,179,920	4.48	9,667,000
Idaho	121,786	878,946	.36	1,562,234
Michigan	697,158	46,853,130	3.36	46,853,130
Montana [2]	491,953	55,826,812	5.67	65,476,375
Nevada	1,200,383	28,378,215	1.18	28,489,610
New Mexico [3]	1,102,126	22,285,092	1.01	26,947,000
Oregon				11,453
Texas	45	2,000	2.22	2,000
Utah [4]	3,524,073	65,565,215	.93	73,583,130
Washington				5,781
Eastern States	[5] 358,404	13,626,320	1.90	13,626,320
	[5] 8,513,819	355,333,054	2.09	381,285,194

[1] Considerable copper was derived from ores classed as siliceous ores.
[2] Considerable copper was recovered from precipitates.
[3] Considerable copper was derived from ores classed as lead-zinc ores.
[4] Considerable copper was recovered from precipitates and from ores classed as lead-zinc ores and gold ores.
[5] Includes copper concentrates from pyritiferous magnetite ore from Pennsylvania.

Copper ores produced in the United States, 1924–33, and average yield in copper, gold, and silver

Year	Smelting ores		Concentrating ores		Total				
	Short tons	Yield in copper (percent)	Short tons	Yield in copper (percent)	Short tons	Yield in copper (percent)	Yield per ton in gold (ounce)	Yield per ton in silver (ounce)	Value per ton in gold and silver
1924	3,554,915	5.08	44,427,264	1.33	49,178,315	1.59	0.0063	0.325	$0.35
1925	3,876,733	4.90	48,186,769	1.28	53,103,014	1.54	.0065	.338	.37
1926	3,767,947	4.75	52,083,784	1.24	57,181,894	1.46	.0064	.293	.31
1927	3,407,610	4.67	49,179,035	1.23	56,725,460	1.41	.0065	.255	.28
1928	3,766,368	4.44	54,214,485	1.24	62,097,132	1.41	.0067	.236	.28
1929	4,235,192	4.60	[1] 59,727,536	1.22	[1] 68,421,853	1.41	.0067	.262	.28
1930	2,983,912	4.57	[1] 41,327,237	1.23	[1] 47,381,509	1.43	.0070	.287	.26
1931	1,519,915	5.38	[1] 30,056,857	1.33	[1] 34,050,961	1.50	.0063	.281	.21
1932	758,623	6.98	[1] 10,964,749	1.51	[1] 12,320,194	1.83	.0080	.421	.28
1933	872,033	6.30	[1] 7,475,988	1.63	[1] 8,387,612	2.11	.0126	.696	.57

[1] Includes old tailings, etc.

REFINERY PRODUCTION

The refinery output of copper in the United States in 1934 was made by 10 plants; 8 of these employed the electrolytic method, and 2 employed the furnace process on Lake Superior copper.

There are 5 large electrolytic refineries on the Atlantic seaboard, 3 lake refineries on the Great Lakes, and 4 refineries west of the Great Lakes; 1 at Great Falls, Mont.; 1 at Tacoma, Wash.; 1 at El Paso, Tex.; and 1 at Clifton, Ariz. Of the above plants the lake refinery of the Quincy Mining Co. and the plant of the Phelps Dodge Corporation that produces furnace-refined copper at Clifton, Ariz., were idle in 1933 and 1934.

In addition to the plants mentioned above the electrolytic plants at Ajo and Inspiration, Ariz., make electrolytically refined copper direct from the liquors obtained from leaching operations; this copper is shipped as cathodes to other refineries, where it is melted and cast into merchant shapes and accounted for in the production reported by the refineries that cast the copper into shapes. The plants at Ajo and Inspiration both were idle throughout 1933 and 1934; the Ajo plant was idle also in 1931 and 1932.

Numerous plants in different parts of the country also make a considerable output from old copper and from brass and other alloys of copper. The output of the regular refining plants is in the form of electrolytic, casting, and lake copper.

Refinery production from ores of domestic and foreign origin is shown in the following table. The domestic figure compares with smelter production from domestic sources, the main difference being the time factor.

Copper is marketed in various forms, such as casting and pig copper, lake copper, and electrolytic copper. The differences in these various grades were explained on page 739 of the copper chapter of Mineral Resources, 1930. The following table also gives the production of each grade by regular refineries during the past 5 years from domestic, foreign, and secondary sources. The output of plants that treat secondary materials only is not included in this table. For total production of secondary copper see table on page 59.

Primary and secondary copper produced by regular refining plants in the United States and imported, 1930–34, in pounds

	1930	1931	1932	1933	1934
Primary:					
Domestic:[1]					
Electrolytic	1,228,416,733	947,065,977	[2] 373,492,550	[2] 421,318,802	414,020,483
Lake	142,985,522	105,222,177	[2] 53,815,281	[2] 59,497,370	51,681,901
Casting	19,821,950	22,317,887	17,770,043	521,859	355,976
	1,391,224,205	1,074,606,041	445,077,874	481,338,031	466,058,360
Foreign:[1]					
Electrolytic	765,189,037	426,307,093	235,240,651	260,048,594	424,523,995
Casting and best select	645,936	529,199	549,209	191,927	137,510
Refinery production, new copper	2,157,059,178	1,501,442,333	680,867,734	741,578,552	890,719,865
Imports refined copper	86,210,331	174,449,893	167,793,988	10,863,358	[3] 54,833,436
Total new refined copper made available	2,243,269,509	1,675,892,226	848,661,722	752,441,910	945,553,301
Secondary:					
Electrolytic	279,423,370	156,099,339	120,397,873	170,878,078	243,189,320
Casting	1,106,114	28,914	56,654	160,214	720,514
	280,529,484	156,128,253	120,454,527	171,038,292	243,909,834
Grand total	2,523,798,993	1,832,020,479	969,116,249	923,480,202	1,189,463,135

[1] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.
[2] Some copper from Michigan was electrolytically refined at an eastern refinery and is included as electrolytic copper.
[3] Data for 1934 include copper imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given in previous years.

The following table shows the copper cast in different forms in 1933 and 1934. It will be noted that the totals are not the same as the production of refined copper. Considerable metal is remelted and recast to meet changing market requirements.

Copper cast in different forms in the United States in 1933–34

Form	1933		1934	
	Pounds	Percent	Pounds	Percent
Wire bars	392,000,000	43.27	432,000,000	38.06
Cathodes	219,000,000	24.17	369,000,000	32.51
Cakes	160,000,000	17.66	182,000,000	16.04
Ingots	45,000,000	4.97	59,000,000	5.20
Other forms	90,000,000	9.93	93,000,000	8.19
	906,000,000	100.00	1,135,000,000	100.00

Copper sulphate.—The production of hydrous copper sulphate or bluestone by copper refineries in the United States in 1934 was 24,862,944 pounds having a copper content of 6,333,000 pounds compared with 25,436,881 pounds having a copper content of 6,479,000 pounds in 1933.

The production of copper sulphate by plants other than the regular primary refineries was 27,876,405 pounds with a reported copper content of 7,130,000 pounds in 1934 compared with 23,587,922 pounds with a reported copper content of 6,085,000 pounds in 1933.

SECONDARY COPPER

Secondary copper includes material recovered from remelting old copper and copper scrap and from the treatment of copper alloys or alloys treated without separation of the copper. The following table summarizes the production of secondary copper during the past 6 years. Further details can be found in the chapter on Secondary Metals.

Secondary copper produced in the United States, 1929–34, in short tons

	1929	1930	1931	1932	1933	1934
Copper as metal	297,600	244,800	188,300	140,500	193,100	220,400
Copper in alloys	328,950	222,400	158,700	107,680	145,000	157,000
Total secondary copper	626,550	467,200	347,000	248,180	338,100	377,400
From new scrap	222,200	125,000	85,700	67,200	77,800	66,500
From old scrap	404,350	342,200	261,300	180,980	260,300	310,900
Percent of domestic mine output	63	66	66	104	177	159

The production of secondary copper has held up during the depression much better than that of primary copper. As a result, secondary production in 1934 amounted to 159 percent of the mine output compared to only 63 percent in 1929. The decline in secondary production since 1929 was only 40 percent whereas mine production declined 76 percent. On account of the low level of manufacturing activity the quantity of secondary copper derived from new scrap has decreased much more than that derived from old scrap. Higher copper prices in 1934 increased the supply of old scrap and contributed to the large increase in the supply of secondary metal, necessitating revisions in the marketing features of the code. The monthly sales quota allocated to secondary copper was increased from 9,500 to 10,250 tons in June 1934, and in addition from September 15 to the end of the year primary producers waived their sales quota to permit unloading of accumulated scrap and byproduct copper.

CONSUMPTION AND USES

New supply.—The total available supply of new copper consists of the total output of primary copper by refineries plus imports of refined copper. In 1934 it amounted to 945,553,301 pounds, an increase of 26 percent over 1933. (See table on page 58.) If this figure is reduced by the quantity of refined copper exported and adjusted for changes in stocks at refineries an estimate of the quantity of new copper made available for domestic consumption is obtained. This computation is made in the table which follows. It should be noted, however, that exports and stocks include some refined secondary copper which cannot be determined separately and that actual consumption of new copper would differ from the figures shown in the table by the changes in consumers' stocks on which published data are not available.

New refined copper withdrawn from total year's supply on domestic account, 1930–34, in pounds

	1930	1931	1932	1933	1934
Total supply of new copper	2,243,269,509	1,675,892,226	848,661,722	752,441,910	945,553,301
Stock at beginning of year	306,000,000	615,000,000	924,600,000	1,004,000,000	813,000,000
Total available supply	2,549,269,509	2,290,892,226	1,773,261,722	1,756,441,910	1,758,553,301
Copper exported [1]	669,252,807	464,227,033	250,058,954	264,742,586	544,276,582
Stock at end of year	615,000,000	924,600,000	1,004,000,000	813,000,000	569,000,000
	1,284,252,807	1,388,827,033	1,254,058,954	1,077,742,586	1,113,276,582
Withdrawn on domestic account	1,265,016,702	902,065,193	519,202,768	678,699,324	645,276,719

[1] Includes refined copper in ingots, bars, rods, or other forms.

The quantity of new copper withdrawn on domestic account in 1934, as shown in the foregoing table, was 5 percent below that in 1933 and 64 percent below the record year 1929. Although exact data are not available it is believed that this supply was augmented by withdrawals from consumers' stocks, so that actual consumption of new copper in 1934 probably was higher than in 1933.

Total supply.—Adding 754,800,000 pounds of secondary copper and copper in alloys produced during the year to the 645,276,719 pounds of new refined copper withdrawn on domestic account gives a total supply of 1,400,076,719 pounds of new and old copper available for domestic consumption in 1934. The secondary copper, however, includes remelted new scrap as well as old scrap. The new scrap represents a revolving supply required in manufacturing, so that a more significant figure of supply available for domestic consumption is obtained by adding to the new refined copper only the secondary copper derived from old scrap, which was 621,800,000 pounds. The total available for consumption by this calculation would be 1,267,000,000 pounds in 1934 compared with 1,199,000,000 pounds in 1933 and 2,587,000,000 in 1929.

Industrial use of copper.—The American Bureau of Metal Statistics estimates the actual consumption of new and old copper in the United States by uses. These data for the past 6 years are shown in the following table:

Estimated use of copper in the United States, 1929–34, in short tons

	1929	1930	1931	1932	1933	1934
Electrical manufactures [1]	261,000	221,000	162,000	90,000	90,000	101,000
Telephones and telegraphs	164,000	122,000	70,000	27,000	18,000	18,000
Light and power lines [2]	127,000	130,000	85,000	49,000	33,000	40,000
Wire cloth	9,000	9,200	4,900	4,200	5,000	4,600
Other rod and wire	106,200	93,700	55,000	30,000	46,000	40,000
Ammunition	6,900	5,100	5,000	3,900	10,500	12,200
Automobiles [3]	138,200	87,000	61,600	32,300	49,000	63,000
Buildings [4]	59,000	50,000	45,000	29,000	36,000	36,000
Castings, n. e. s.[5]	79,500	55,400	36,000	27,000	36,000	36,000
Clocks and watches	4,300	2,600	2,000	1,500	2,800	1,800
Coinage	1,200	850	100	100	100	900
Copper-bearing steel	2,600	1,900	1,200	800	1,500	2,100
Fire-fighting apparatus	2,400	1,700	1,300	1,000	1,100	1,000
Radiators, heating	2,100	3,000	1,700	1,000	2,400	2,400
Radio receiving sets	15,500	13,000	10,000	7,000	11,500	12,600
Railway equipment	9,600	8,600	1,800	700	800	2,600
Refrigerators	17,200	15,000	13,000	9,000	11,400	16,200
Shipbuilding	2,400	5,000	3,200	2,100	1,800	3,700
Washing machines	4,500	1,200	1,600	1,500	1,000	1,900
Water heaters, household	2,300	1,800	1,400	1,000	1,500	1,500
Other uses	70,000	57,000	40,000	27,300	40,000	42,000
Manufactures for export	74,900	71,100	48,200	22,600	15,600	25,500
Total	1,159,800	956,150	650,000	368,000	415,000	465,000

[1] Generators, motors, electric locomotives, switchboards, light bulbs, etc.
[2] Transmission and distribution wire and bus bars.
[3] Does not include starter, generator, and ignition equipment.
[4] Excludes electrical work.
[5] Bearings, bushings, lubricators, valves, and fittings.

According to the foregoing table the use of copper in 1934 increased 12 percent over 1933 but was 60 percent below 1929. The principal uses in 1934 and the percentage of the total taken by each were as follows: Electrical manufactures, 22; automobiles, 14; light and power lines, 9; other rod and wire, 9; buildings, 8; castings, 8; telephones and telegraphs, 4; refrigerators, 3; radio receiving sets, 3; and ammunition, 3. Of these uses only "other rod and wire" showed a decrease from 1933. There was no change in the quantity of copper used in buildings, castings, and telephones and telegraphs, but all of the other important uses showed substantial increases. Consumption of copper in all of the above uses except ammunition was considerably below the 1929 level. The largest declines were in the uses associated with electric power, telephones, and telegraphic equipment.

STOCKS

The following table gives domestic stocks of copper reported by smelters and refineries:

Stocks of copper in the United States, January 1, 1929–35, in pounds

Year	Refined copper	Blister and materials in process of refining	Year	Refined copper	Blister and materials in process of refining
1929	114,000,000	423,000,000	1933	1,004,000,000	378,000,000
1930	306,000,000	500,000,000	1934	813,000,000	388,000,000
1931	615,000,000	450,000,000	1935	569,000,000	389,000,000
1932	924,600,000	348,000,000			

Stocks of refined copper in the United States declined again in 1934 and were the lowest since the end of 1929, according to reports submitted to the Bureau of Mines. The decline in 1934 was due largely to an increase of about 236,000,000 pounds in net exports of refined copper. Consumers' stocks are believed to be excessively high, but published data on this point are not available.

According to the Wall Street Journal (Jan. 17, 1935, p. 5) world stocks of refined copper on January 1, 1935, were 988,500,000 pounds compared with 1,303,500,000 pounds a year previous. During 1934 stocks in North and South America decreased from 1,068,500,000 to 746,500,000 pounds, whereas those elsewhere increased from 235,000,000 to 242,000,000 pounds.

PRICES

Reports to the Bureau of Mines from copper selling agencies in the United States indicate that 887,197,000 pounds of copper were delivered to domestic and foreign purchasers in 1934 at an average price (f. o. b. refinery) of 8 cents per pound. These deliveries are exlusive of copper produced and delivered outside of the United States. The average price for 1934 was 1.6 cents higher than that received in 1933 and 1.7 cents higher than that for 1932, the lowest on record.

According to the Engineering and Mining Journal the quotation for electrolytic copper (domestic refinery basis) was 8.025 cents per pound at the beginning of the year. Before the middle of January it had declined to 7.525 cents, which proved to be the low for the year. Following some fluctuations during the latter half of January the price settled to 7.775 cents during February and March. Early in April an upward movement anticipating approval of the Copper Code raised the quotation to 8.275 cents where it stood on April 25; the following day the code went into effect and copper sold under the code provisions was designated as Blue Eagle copper.

On April 26 quotations for Blue Eagle copper were 8.50 cents, f. o. b. Valley and 8.275 cents refinery basis, which represented no change over the price of the preceding day. For a short period there was some concern over the fact that non-Blue Eagle copper was available at concessions, but this disturbing influence was removed by the following resolution adopted by the Code Authority on May 1:

Resolved, That the provisions of the Code in regard to "non-Blue Eagle" copper require further consideration and investigation, and pending such consideration and investigation prior to May 22, 1934, that, during such period or until further action prior thereto, no copper other than "Blue Eagle" copper shall be sold in the domestic market.

Resolved, That the Code Authorities, of N. E. M. A., and Wire and Cable subdivision of Copper and Brass Mill Products Industry be requested to cooperate by refraining from purchasing or fabricating copper other than "Blue Eagle" copper pending further consideration and cooperative action in order to carry out the spirit and intent of the Copper Code.

Quotations for Blue Eagle copper were unchanged until the latter half of June, when they were raised to 8.775 cents refinery basis. This price held for the rest of the year and was the high for the year. The average was 8.428 cents per pound compared with 7.025 cents in 1933, 5.555 cents the record low of 1932, and 18.107 cents in1929.

Quotations on copper for export, which were established after the imposition of the tariff in 1932, were slightly in excess of domestic quotations during February and March 1934. Heavy selling pressure on the foreign market, however, caused a sharp decline in the London price, so that in December the average quotation for export was over 2 cents below the domestic price.

Average monthly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, United States, and for spot copper at London, 1933–34, in cents per pound

Month	1933				1934			
	Domestic f. o. b. refinery [1]	Domestic f. o. b. refinery [2]	Export f. o. b. refinery [2]	London spot [2 3]	Domestic f. o. b. refinery [1]	Domestic f. o. b. refinery [2]	Export f. o. b. refinery [2]	London spot [2 3]
January	4.87	4.775	4.741	4.989	8.06	7.890	7.831	8.028
February	4.87	4.775	4.710	4.974	7.87	7.777	7.844	8.081
March	5.13	5.011	4.779	4.961	7.87	7.775	7.837	8.076
April	5.56	5.395	5.185	5.382	8.27	8.173	8.053	8.291
May	6.81	6.698	6.569	6.700	8.37	8.275	7.913	8.151
June	7.87	7.773	7.484	7.570	8.68	8.594	7.705	7.965
July	8.78	8.635	8.446	8.620	8.87	8.775	7.146	7.376
August	8.87	8.768	7.937	8.086	8.87	8.775	6.885	7.119
September	8.87	8.753	7.788	7.984	8.87	8.775	6.586	6.812
October	8.13	7.950	7.557	7.706	8.87	8.775	6.315	6.502
November	8.03	7.881	7.647	7.793	8.87	8.775	6.513	6.731
December	8.00	7.885	7.710	7.840	8.87	8.775	6.619	6.864
Average for year	7.15	7.025	6.713	6.877	8.53	8.428	7.271	7.496

[1] As reported by the American Metal Market Co.
[2] As reported by Engineering and Mining Journal.
[3] Conversion of English quotations into American money based on average rates of exchange recorded by the Federal Reserve Board of the Treasury.

Average yearly quoted prices of electrolytic copper for domestic and export shipment, f. o. b. refineries, United States, and for spot copper at London, 1925–34, in cents per pound

	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
Domestic f. o. b. refinery [1]	14.16	13.93	13.05	14.68	18.23	13.11	8.24	5.67	7.15	8.53
Domestic f. o. b. refinery [2]	14.042	13.795	12.920	14.570	18.107	12.982	8.116	5.555	7.025	8.428
Export f. o. b. refinery [2]	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	6.713	7.271
London spot [2] [4]	14.401	14.200	13.468	15.040	18.413	13.355	8.522	5.629	6.877	7.496

[1] As reported by the American Metal Market Co.
[2] As reported by Engineering and Mining Journal.
[3] Not available. Export quotation was established after imposition of tariff in 1932.
[4] Conversion of English quotations into American money based on average rates of exchange recorded by the Federal Reserve Board of the Treasury.

FOREIGN TRADE

United States imports and exports of copper constitute a well-balanced trade through which the smelting, refining, and manufacturing facilities of this country are utilized to treat foreign raw materials and to return refined copper and manufactures of copper abroad. Eighty-seven percent by weight of the copper imported in 1934 was contained in ore, concentrates, and unrefined furnace products. Much of the remainder—probably most of it—though already refined was ingots to be remelted and recast in the United States. On the contrary, nearly 91 percent of the exports consisted of refined copper and primary manufactures therefrom.

Normally the exports of copper greatly exceed the imports, but recently this has not been the case. Exports in 1932 were only 84 percent of imports, although in addition an unrecorded quantity of copper was exported in manufactures, such as electrical machinery. In 1933 and 1934, however, a more normal relation recurred, exports being 20 and 47 percent, respectively, greater than imports.

Imports.—Total imports of unmanufactured copper into the United States in 1934 were 426,571,568 pounds, an increase of 139 million pounds (48 percent) over 1933 but a decrease of 56 percent from the record imports of 1929. There were large increases in shipments of refined copper from Chile and of copper concentrates from Canada and Chile, but the major part of the increase in total receipts of copper in 1934 was due to the rise in imports of unrefined copper (mostly blister) from Chile, Mexico, Yugoslavia, Peru, and Canada. The intake of blister copper from Africa in 1934 was about 10 percent below that in 1933. Of the total copper imported in 1934 Chile contributed 35 percent, Mexico 25 percent, Peru 14 percent, Canada 10 percent, Africa 6 percent, Yugoslavia 5 percent, and Cuba 4 percent.

Imports of scrap brass totaled 243 tons in 1934 compared with 1,085 tons in 1933 and 7,031 tons in 1929.

Copper (unmanufactured) imported into the United States, 1934, in pounds[1]

Country	Ore (copper content)	Concentrates (copper content)	Regulus, black or coarse copper, and cement copper (copper content)	Unrefined black blister and converter copper in pigs or converter bars	Refined in ingots, plates, or bars	Old and scrap copper fit only for remanufacture, and scale and clippings
Africa:						
British:						
Union of South		27,814				
Other South		51,582				
Mozambique		187,735	6,360	27,207,099		
Australia	880	1,046,000	69,228			
Canada	35,869	16,280,889	2,341,526	25,301,385	108	278,218
Chile	10,645,367	12,117,995	52,905	72,225,646	52,481,264	23,190
Cuba	17,882	15,932,880				1,950
France			332,842			27,762
Germany			534,646		953	624
Mexico	510,379	64,648		103,883,092	2,350,080	11,130
Peru	401,977	128,692		59,026,535		3,076
Spain			25,015			
United Kingdom			99,964		1,031	
Venezuela						
Yugoslavia	159			20,701,848		33,296
Other	942,588	685,380	278,334	122,047		71,698
Total	12,555,101	46,523,615	3,740,820	308,467,652	54,833,436	450,944

[1] Data for 1934 include copper imported for immediate consumption plus material entering the country under bond and are comparable to "General imports" given in previous years.

Copper (unmanufactured) imported into the United States, 1929–34, in pounds[3]

1929	974,312,201	1932	391,991,342
1930	817,154,236	1933	287,433,540
1931	585,892,098	1934	[3]426,571,568

Exports.—Exports of copper of all classes totaled 625,485,074 pounds in 1934, an increase of over 276 million pounds (79 percent) over 1933 but a decrease of 44 percent from 1928. The large increase over 1933 was due largely to a 111-percent increase in shipments of refined bars and ingots. Exports of copper in ore, concentrates, blister, etc., and old and scrap copper decreased 28 and 11 percent, respectively.

France continued to be the principal consumer of American copper in 1934, having taken 21 percent of the total. Exports to Japan were 19 percent of the total and were 83 million pounds higher than in 1933. Other important consumers and the percentage each took were: United Kingdom 13, Germany 13, Italy 9, Sweden 5, and the Netherlands and Belgium 4 percent each. All of these countries except Belgium took considerably more copper in 1934 than in 1933. The following table shows copper exports to the principal importers of United States copper during the past 6 years:

Copper exported from the United States (all forms), by principal countries of destination, 1929–34, in millions of pounds

Country	1929	1930	1931	1932	1933	1934
Belgium	49	36	36	18	33	27
Canada	76	44	19	2	1	1
France	181	148	120	75	104	131
Germany	200	110	97	50	44	83
India (British)	5	8	6	2	2	12
Italy	88	81	44	49	30	55
Japan	13	5	3	3	36	119
Netherlands	41	39	32	13	15	27
Sweden	33	31	29	16	12	29
United Kingdom	217	175	124	73	29	84
U. S. S. R. (Russia)	16	15	9			
Others	79	61	39	27	43	57
Total	998	753	558	328	349	625

[3] Data for 1934 include copper imported for immediate consumption plus material entering the country under bond and are comparable to "General imports" given in previous years.

Copper exported from the United States, 1934, in pounds

Country	Ore, concentrates, composition metal, and unrefined copper (copper content)	Refined: Bars, ingots, or other forms	Refined: Rods	Old and scrap	Pipes and tubes	Plates and sheets	Wire (except insulated)	Insulated wire and cable	Other copper manufactures
Belgium	3, 357, 305	18, 522, 193	3, 543, 233	1, 586, 113	7, 109	----------	----------	57, 989	
Canada	5, 563	161, 596	429, 897	46, 410	249, 385	160, 892	34, 079	330, 613	
China	----------	3, 755, 398	----------	55, 422	82, 237	3, 569	685, 646	298, 357	
Denmark	----------	2, 731, 869	224, 020	22, 828	2, 749	----------	----------	11, 082	
France	10, 910, 746	116, 318, 397	282, 960	2, 985, 811	7, 750	52, 624	7, 147	20, 118	
Germany	112, 689	72, 761, 664	----------	10, 126, 806	23, 537	69, 853	45, 166	28, 127	
India (British)	----------	1, 015, 541	1, 905, 387	----------	2, 611	8, 211, 097	710, 948	161, 368	
Italy	11, 532, 415	43, 041, 104	269, 295	70, 675	1, 735	3, 637	1, 679	14, 489	(1)
Japan	118	113, 769, 412	123, 380	4, 827, 634	77	12, 158	50, 231	18, 237	
Netherlands	560, 180	21, 781, 872	3, 391, 777	1, 558, 188	11, 817	329	1, 640	28, 730	
Norway	----------	1, 897, 124	3, 590, 273	----------	661	----------	5, 298	4, 583	
Spain	----------	22, 405	----------	2, 367, 666	5, 006	----------	200, 488	96, 258	
Sweden	----------	28, 386, 207	----------	224, 250	1, 002	----------	----------	26, 764	
United Kingdom	27, 492	82, 415, 204	70, 041	1, 235, 122	13, 504	363, 944	310	27, 231	
Other	6, 259, 675	18, 152, 578	5, 713, 755	83, 463	1, 058, 416	643, 649	2, 472, 916	6, 923, 079	
	32, 766, 183	524, 732, 564	19, 544, 018	25, 190, 388	1, 467, 596	9, 521, 752	4, 215, 548	8, 047, 025	(1)
Total value	$2, 701, 202	$39, 650, 904	$1, 744, 876	$1, 827, 252	$298, 260	$960, 501	$416, 954	$1, 663, 617	$500, 974

[1] Figures for quantity not recorded.

Copper [1] exported from the United States, 1929–34

Year	Pounds		Total value	Year	Pounds		Total value
	Metallic [2]	Total			Metallic [2]	Total	
1929	992,895,119	998,474,549	$181,684,409	1932	295,356,719	328,222,700	$20,998,816
1930	753,114,927	753,294,022	104,316,175	1933	303,825,790	349,253,716	24,639,027
1931	557,574,235	557,873,744	54,230,992	1934	592,718,891	625,485,074	49,764,540

[1] Exclusive of "Other copper manufactures", valued at $1,025,875 in 1930, $516,818 in 1931, $237,004 in 1932, $278,229 in 1933, and $500,974 in 1934; quantity not recorded.
[2] Exclusive of ore, concentrates, and composition metal. Exclusive also of unrefined copper, figures for which are not separable from those for ore and concentrates.

Copper sulphate (blue vitriol) exported from the United States, 1929–34

Year	Pounds	Value	Year	Pounds	Value
1929	6,419,688	$368,481	1932	4,132,529	$114,579
1930	5,061,554	252,614	1933	2,749,299	92,964
1931	7,190,919	276,575	1934	3,858,629	128,756

Brass and bronze exported from the United States, 1933–34

	1933		1934	
	Pounds	Value	Pounds	Value
Ingots	131,223	$11,425	77,172	$8,562
Scrap and old	30,695,384	1,367,759	60,392,875	3,286,523
Bars and rods	770,920	114,258	1,250,412	209,147
Plates and sheets	262,566	54,472	527,721	109,976
Pipes and tubes	855,325	151,487	708,036	142,729
Pipe fittings and valves	843,069	478,914	1,283,821	720,212
Plumber's brass goods	432,220	214,210	600,089	306,236
Wire of brass or bronze	240,004	50,449	416,808	98,745
Brass wood screws	(1)	13,948	(1)	21,218
Hinges and butts of brass or bronze	(1)	25,021	(1)	26,494
Other hardware of brass or bronze	(1)	148,816	(1)	234,503
Other brass and bronze manufactures	(1)	742,653	(1)	1,057,569
	-------------	3,373,412	-------------	6,221,914

[1] Weight not recorded.

Unmanufactured brass exported from the United States, 1929–34

[Ingots, bars, rods, plates, and sheets]

Year	Pounds	Value	Year	Pounds	Value
1929	7,627,717	$1,597,758	1932	1,843,358	$242,167
1930	6,575,452	1,230,558	1933	1,164,709	180,155
1931	3,896,002	525,170	1934	1,855,305	327,685

WORLD ASPECTS OF COPPER INDUSTRY

International cooperation.—With the collapse of Copper Exporters, Inc., in 1932, there was a temporary lapse of international cooperation in the copper industry. Subsequent attempts to reach an agreement failed for various reasons, including the chaotic condition of the industry within the United States, the refusal of Canadian producers to curtail their output of byproduct copper, widespread depreciation of currency, and the imposition of a duty on copper imported into the United States.

Developments in 1934 again emphasized the need for some measure of control. Production outside the United States was increasing more rapidly than consumption, so that an increase in foreign stocks of copper was imminent. This situation was aggravated by a large decline in purchases by Germany during the latter part of the year, caused by the critical foreign-exchange situation, and by a large increase in shipments from the United States to Europe. In consequence there was a marked decline in the London price of copper. Meanwhile cooperation of producers in the United States under the N. R. A. led to the belief that American producers with foreign interests could reach an agreement on policy regarding foreign markets. Accordingly, international negotiations were resumed during the latter part of 1934 which ultimately led to an agreement early in 1935.

On March 29, 1935, C. F. Kelley, chairman of the copper conference, issued the following statement:

The principal producers of copper outside of the United States have been in conference during the past three weeks considering the problems of the industry in connection with the production of metal from sources outside of the United States and its sale in foreign markets. The conference dealt exclusively with the foreign situation and did not consider production or sales within the United States from which market the participants are excluded by reason of the existing excise tax of four cents per pound of copper and which market is covered by the Presidential Order approving the Copper Code.

Notwithstanding the demand in foreign markets has been in excess of previous requirements, foreign production during recent months has been at a rate which if continued would not only retard the liquidation of existing surplus stocks of copper but add thereto, resulting in a wholly unsatisfactory price level in foreign markets.

Participating in the conference were representatives of foreign companies having an aggregate current production of approximately 750,000 tons of copper per year, or more than 75 percent of the total foreign primary production, exclusive of Russia and Japan which import copper from outside sources in addition to their respective productions.

The most important questions considered were productive control, marketing methods and trade practices. Complete accord has been reached upon all subjects considered, i. e.:

1. A curtailment amounting to 240,000 tons of copper per year from current production will be made effective by June 1st;
2. An organization has been created to compile complete statistical information to the end that while an adequate supply of copper will be provided at all times, the accumulation of excess stocks will be avoided;
3. Cooperation in foreign markets of producers other than those who have actively participated in the conference has been assured;
4. Uniform trade practices governing sales, deliveries, and terms of payment will be adopted;
5. Each producer reserves freedom of action within the above limitations. There will be no pooling of sales or fixing of prices, but an effort will be made to insure stable markets and avoid wide fluctuations in price;
6. Subject to certain contingencies, the term of the accord is for a period terminating on July 1, 1938.

According to various press reports the agreement also includes limitation of United States exports of copper to 8,000 tons per month. Canadian producers are said to have agreed to some limitation of their production of byproduct copper.

World smelter production.—World smelter production of copper in 1934 totaled 1,290,000 metric tons, an increase of 23 percent over 1933 but 33 percent below the record output in 1929. Production in the United States increased 11 percent over 1933 whereas that of the rest of the world advanced 26 percent. Since 1929 the United States output has declined 75 percent and that of the rest of the world has increased 13 percent.

The principal producers in 1934 and the percentage of the total output each contributed in 1934 were as follows: United States 19.5, Chile 19.2, Canada 11.8, Northern Rhodesia 11, Belgian Congo 8.7, Japan 5.2, U. S. S. R. (Russia) 4.2, Germany 4.1, Mexico 3.6, and Yugoslavia 3.4. All of these countries except Japan made substantial increases in 1934. Chile's output increased 59 percent, Canada's 29 percent, Northern Rhodesia's 34 percent, and Belgian Congo's about 70 percent. The copper output of North America and South America in 1934 was 60 and 23 percent, respectively, below 1929, whereas that of Africa was 74 percent higher.

World smelter production of copper, 1930–34, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
North America:					
Canada [2]	101,554	110,588	95,710	118,109	151,927
Mexico	54,025	43,738	[3] 34,000	39,900	47,000
United States [4]	729,611	537,175	278,997	227,223	251,225
	885,190	691,501	408,707	385,232	450,152
South America:					
Chile	208,011	215,715	97,517	156,000	248,000
Peru	48,099	45,381	22,531	24,853	27,000
	256,110	261,096	120,048	180,853	275,000
Europe:					
Austria	4,076	3,235	1,987	1,000	(5)
Belgium [6]	14,640	31,400	26,950	35,360	(5)
Czechoslovakia	1,521	1,215	936	779	(5)
France	1,207	1,000	995	1,000	(5)
Germany [7]	59,200	55,500	50,900	49,800	53,000
Great Britain [8]	18,000	16,000	13,000	11,300	(5)
Italy	262	721	427	120	303
Norway	5,149	4,352	5,416	6,694	(5)
Rumania [9]	169	(10)	109	453	(5)
Spain	22,996	25,734	15,555	17,268	(5)
Sweden [11]	5,523	2,854	3,138	6,638	(5)
U. S. S. R. (Russia) [12]	47,500	40,600	46,600	[3] 47,000	53,600
Yugoslavia	24,463	24,351	30,159	40,318	43,600
	[12] 204,706	[12] 206,962	[12] 196,172	[12] 217,730	(5)
Asia:					
China [13]	1,203	157	16	36	(5)
Chosen	589	698	694	785	(5)
India, British	3,022	4,134	4,514	4,900	6,400
Japan	79,033	75,848	71,877	69,033	66,490
U. S. S. R. (Russia) [12]	(12)	(12)	(12)	(12)	(12)
	[12] 83,847	[12] 80,837	[12] 77,101	[12] 74,754	(5)
Africa:					
Belgian Congo	[14] 136,404	[2] 120,000	[2] 54,000	66,596	(5)
Rhodesia:					
Northern	6,370	9,070	68,977	105,877	142,027
Southern	1,334	538	6		
Union of South Africa	7,488	10,225	9,387	8,378	8,328
	151,596	139,833	132,370	180,851	(5)
Oceania: Australia	15,139	13,144	13,521	11,418	(5)
	1,597,000	1,393,000	948,000	1,051,000	[15] 1,290,000

[1] In addition to the countries listed, copper is smelted in Turkey, but data of output are not available.
[2] Copper content of blister produced.
[3] Approximate production.
[4] Smelter output from domestic and foreign ores, exclusive of scrap. The production from domestic ores only, exclusive of scrap, was as follows: 1930, 632,481 tons; 1931, 472,963 tons; 1932, 246,757 tons; 1933, 204,115 tons; 1934, 221,558 tons.
[5] Data not available.
[6] Figures represent blister copper only. In addition to blister copper, Belgium reports a large output of refined copper which is not included above as it is believed produced principally from crude copper from the Belgian Congo and would, therefore, duplicate output reported under the latter country.
[7] Exclusive of material from scrap. (Metallgesellschaft, Stat. Zusammenstell.)
[8] Approximate production. (Imp. Inst., London.)
[9] Smelter output from ores.
[10] Less than 1 ton.
[11] Exclusive of material from scrap.
[12] Output from U. S. S. R. in Asia included under U. S. S. R. in Europe. Figures probably include secondary material.
[13] Exports of ingots and slabs.
[14] In addition to the crude copper smelted in the Belgian Congo, 2,545 tons were smelted in Belgium from matte and alloys produced in the Belgian Congo.
[15] Approximate production, based on the output of the countries shown, which in 1933 contributed nearly 85 percent of the total world output.

World mine production.—Statistics of mine production are of interest, as they show the original sources of the world's supply of copper more accurately than do statistics of smelter output. The following table, which shows mine production during the past 5 years, is compiled largely from official data, much of which is not yet available for 1934.

World mine production of copper, 1930–34, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
North America:					
Canada	137,655	132,586	112,345	136,069	165,511
Cuba	15,693	13,507	5,927	8,957	6,192
Mexico	73,412	54,212	35,123	39,126	44,268
Newfoundland	956	1,459	2,153	3,162	3,859
United States	639,629	479,785	216,010	172,948	214,960
	867,345	681,549	371,558	360,262	434,790
South America:					
Bolivia [3]	3,987	2,049	2,017	1,849	(2)
Chile	220,323	223,513	103,173	164,918	(2)
Peru	50,188	44,753	22,890	25,400	(2)
Venezuela	96	746	----------	----------	(2)
	274,594	271,061	128,080	192,167	(2)
Europe:					
Austria	2,216	1,313	171	133	(2)
Bulgaria [4]	2,000	1,000	500	----------	(2)
Czechoslovakia	1,790	1,252	----------	----------	(2)
Finland	4,986	6,396	6,649	11,362	(2)
France	422	337	435	[4] 400	(2)
Germany	26,972	29,827	30,741	29,434	(2)
Great Britain	49	67	62	41	(2)
Hungary	----------	167	278	315	(2)
Italy	973	438	381	329	(2)
Norway	17,317	8,708	16,944	19,879	(2)
Portugal [4]	4,000	3,000	2,000	2,000	2,000
Rumania [5]	169	(6)	109	453	(2)
Spain	58,400	54,000	35,000	44,000	(2)
Sweden	5,523	1,634	4,309	6,871	(2)
U. S. S. R. (Russia)	[7] 34,100	[7] 31,100	[7] 32,000	[7] 31,500	(2)
Yugoslavia	22,700	28,562	18,946	35,304	(2)
	[7] 181,617	[7] 167,801	[7] 148,525	[7] 182,000	(2)
Asia:					
China [8]	1,203	157	16	36	(2)
Cyprus	5,200	3,900	3,300	4,300	(2)
India, British	11,800	11,600	11,400	11,100	(2)
Japan:					
Japan proper [5]	79,033	75,848	71,013	69,033	66,490
Chosen [5]	589	698	694	785	(2)
Taiwan	3,060	4,117	4,417	[4] 4,500	(2)
U. S. S. R. (Russia)	(7)	(7)	(7)	(7)	(2)
	[7] 100,885	[7] 96,320	[7] 90,840	[7] 89,754	(2)
Africa:					
Algeria	1	----------	35	18	140
Belgian Congo [5]	[9] 138,949	[10] 120,000	[10] 54,000	66,596	110,000
French Equatorial Africa	600	80	452	(2)	(2)
French West Africa	135	200	(2)	(2)	(2)
Morocco, French	----------	----------	----------	(6)	(2)
Rhodesia:					
Northern	8,630	32,923	88,639	131,500	(2)
Southern [5]	1,334	538	6	----------	----------
South-West Africa [11]	15,100	8,400	2,400	----------	----------
Union of South Africa	8,627	10,206	9,403	8,383	7,862
	173,376	172,347	155,000	207,000	(2)
Oceania:					
Australia	13,192	13,749	14,893	14,644	(2)
New Caledonia	50	----------	----------	----------	(2)
Papua [12]	(6)	----------	----------	----------	(2)
	13,242	13,749	14,893	14,644	(2)
	1,611,000	1,403,000	909,000	1,046,000	(2)

[1] In addition to the countries listed, copper is produced in Asiatic Turkey, but data of output are not available.

[2] Data not available.

[3] Copper content of exports.

[4] Approximate production.

[5] Smelter product.

[6] Less than half a ton.

[7] Output from U. S. S. R. in Asia included under U. S. S. R. in Europe.

[8] Exports of ingots and slabs.

[9] Includes 2,545 tons of copper smelted in Belgium from mattes and alloys produced in the Belgian Congo.

[10] Fine copper content of smelter output.

[11] Year ended Mar. 31 of year following that stated.

[12] Copper content of exports for year ended June 30 of year stated.

World consumption.—World consumption of copper in 1934 is estimated by the American Bureau of Metal Statistics at 1,348,000 metric tons, an increase of 20 percent over 1933 but a decrease of 28 percent from the record year 1929. According to this authority, consumption in the United States increased 9 percent in 1934, whereas that of the rest of the world increased 25 percent. The quantity of copper used in the United States in 1934 was 63 percent less than in 1929, whereas that used by the rest of the world set a new record, having exceeded the 1929 total by 12 percent.

The principal consumers in 1934 and the proportion of the total each accounted for were as follows: United States 28 percent, Germany 16, Great Britain 16, Japan 8, France 7, Italy 5, and U. S. S. R. (Russia) 4. All of these countries except France showed substantial increases in 1934. Great Britain and Germany used 52 and 30 percent more copper, respectively.

REVIEW BY COUNTRIES

Belgian Congo.—Unofficial statistics indicate a production of 112,000 metric tons in 1934, an increase of 68 percent over 1933 and a decrease of 18 percent from the record output of 1930. Exports are officially reported at 131,769 tons compared with 94,191 tons in 1933. All of the production is derived from the various mines of Union Minère du Haut Katanga, which is reported to have a capacity of 180,000 tons per year. During 1934 production was increased to meet customer demands, and at the close of the year the company was producing at the rate of 130,000 tons annually. Reserves are estimated at 5,000,000 tons of metal. During the year Japan was negotiating for increased import quotas into Belgium in exchange for greater purchases of Congo copper.

Notman [4] has estimated that the average cost of producing copper at Katanga from 1926 to 1931 was 11.5 cents per pound. Subsequent reduction of freight and other charges and improved metallurgy have lowered costs. At the annual meeting of the company in July 1934 the president stated that costs had been reduced so that the company was able to operate at a profit. The abandonment of the gold standard by Belgium early in 1935 should improve Katanga's competitive position.

Canada.—Smelter production of copper increased 29 percent over 1933. The International Nickel Co., in Ontario; the Noranda Mines, Ltd., in Quebec; the Hudson Bay Mining & Smelting Co., Ltd., in Manitoba; and Granby Consolidated Mining, Smelting & Power Co., in British Columbia, are the largest producers. Most of the copper is produced as a byproduct from extraction of other metals. International Nickel increased its output from 61,400 short tons in 1933 to 97,600 tons in 1934. At Noranda, where gold and silver produce the most revenue, the copper output rose from 32,500 to 35,100 tons. Hudson Bay was the only important producer to reduce output, as it declined from 20,500 to 18,700 tons. More zinc than copper is produced at this mine. At Granby production advanced from 17,200 to 18,500 tons.

[4] Notman, Arthur, Finds Copper Costs Higher for Katanga than for Utah: Am. Metal Market, vol. 40, no. 63, Apr. 4, 1933, p. 2.

Owing to the byproduct nature of their copper, Canadian producers have not been enthusiastic about curtailing output to meet any international agreement for reducing production. No official statement has been issued on the status of Canadian producers in the recent agreement, but rumors in the press indicate that they have agreed to keep production at a minimum, commensurate with the demand for their other products.

Chile.—The smelter production of copper in Chile in 1934 amounted to 248,000 metric tons, an increase of 59 percent over the 156,000 tons produced in 1933. The productive capacity of the Chilean copper industry is estimated at 318,000 metric tons [5] of bar and blister copper, indicating that copper production in Chile in 1934 was at 78 percent of capacity.

All three large producers (American-controlled) produced more copper in 1934 than in 1933, Andes having increased from 16,200 to 24,200 tons, Chile from 55,800 to 97,700 tons, and Braden from 79,500 to 115,100 tons.

Cuba.—Mine production in 1934 decreased 31 percent from the previous year. The Minas de Matahambre is the principal producer. Cuban copper enters the United States free of duty under the Platt Amendment and was allotted a sales quota of 525 short tons per month by the Copper Code Authority.

France.—France ranks fifth in copper consumption, having used 90,700 metric tons or 7 percent of the world total in 1934. This was 16 percent below the quantity consumed in 1933, owing to recession in industrial activity. As France produces very little copper her needs are purchased abroad. In 1934 imports of unmanufactured copper totaled 94,000 tons; the United States supplied 55 percent and Belgium 24 percent.

Germany.—Germany ranks second to the United States in copper consumption. Revival of industry in 1934 resulted in a large increase in the demand for copper from 169,900 to 221,400 metric tons (30 percent). As domestic mines supplied only about 10 percent of the 1934 needs large increases in imports of raw materials were required. Net imports of copper ore increased from 230,000 to 320,000 tons and of crude and refined copper from 120,000 to 168,000 tons. Much of the ore intake is cupriferous pyrites residue, which comes from neighboring European countries. Imports of crude and refined copper totaled 180,000 tons; Africa supplied 39 percent, United States 28 percent, and Chile 13 percent.

The critical foreign-exchange situation resulted in stringent restrictions on use and imports of copper. In June 1934 exportation of raw copper, copper scrap of any kind, copper coins, brass, bronze, etc., was prohibited. The Mansfield mine continued operation under Government subsidy in 1934.

Great Britain.—Although Great Britain is one of the world's largest consumers of copper, domestic mine production is negligible, and the domestic smelter output is only 5 percent of the total need. Consumption in 1934 was 218,000 long tons, an increase of 52 percent over 1933 and 48 percent over 1929. This necessitated a large increase in imports of crude and refined copper—from 142,000 tons

[5] Atwood, Franklin B., Improvement Maintained in Chilean Copper Industry: Foreign Trade Notes, vol. 4, no. 1, Jan. 27, 1935, p. 3.

in 1933 to 251,000 tons in 1934. Chile supplied 36 percent of the 1934 total, Canada 23 percent, Africa 22 percent, and the United States 15 percent. Imports from all of these sources increased in 1934.

Japan.—The smelter production of copper in Japan in 1934 was 66,490 metric tons compared with 69,033 tons in 1933. As consumption increased from 83,000 to 113,000 tons imports also were increased from 13,000 to 47,000 tons. Virtually all of the 1934 imports were credited to the United States.

Copper production in Japan is controlled largely by Sumitomo and Furukawa. In addition to their own production these two concerns purchase the entire output of the smaller mines.

Mexico.—Smelter production increased about 18 percent in 1934. Cananea (Anaconda) increased its output from 25,897 to 30,216 short tons and Boleo produced 9,038 tons in 1934 compared with 9,430 tons in 1933. The Moctezuma mine (Phelps Dodge) has been idle since 1932.

Peru.—The smelter production of copper in Peru in 1934 was 27,000 metric tons compared with 24,853 tons in 1933.

The bulk of the copper output in Peru comes from operations of the Cerro de Pasco Corporation. Early in 1934 the corporation resumed operations at its Casapalca mines, which had been closed since 1931. On April 30 the Mahr drainage tunnel, which was begun in 1929, was completed to a point directly beneath the Natividad shaft at the Morococha mine, a distance of 30,564 feet.

Northern Rhodesia.—Copper production again broke all previous records, totaling 156,558 short tons or an increase of 34 percent over 1933. Rhokana, Roan Antelope, and Mufulira all shared in the increase.

Production at Rhokana was increased from 61,500 tons in 1933 to 76,400 tons in 1934, most of the production coming from the N'Kana mine. A 36,500-ton electrolytic refinery was completed at N'Kana and went into operation early in 1935. The Mindola mine was being equipped for operation, so that by 1937 the company should be in a position to produce 10,000 tons of copper per month. To provide capital for development £1,500,000 in preferred shares were issued in 1934. Total reserves at N'Kana, N'Changa, and Mindola were reported at 266,930,000 tons containing over 11,000,000 tons of copper (4.3 percent).

Roan Antelope increased production from 54,898 to 70,142 tons in 1934. Smelter capacity was increased by the addition of a second reverberatory furnace. Ore reserves were reported at 101,385,000 tons containing 3.43 percent copper. According to press reports dated May 29, 1935, the native workers struck for increased wages. Several natives were killed in rioting, and troops were dispatched to the area to protect the white population.

Production at Mufulira appears to have approximated 10,000 tons in 1934. A 1,500-ton concentrator was completed in 1931, but by arrangement with other world producers production was delayed until the latter part of 1933. In 1934 it was decided to erect a smelter and to enlarge the plant to treat 2,000,000 tons of ore (75,000 tons of copper) annually. To provide capital for this expansion £1,000,000 of debentures were issued. Ore reserves at the Mufulira, Chambishi, and Baluba mines totaled 162,000,000 tons, averaging 4.14 percent copper.

Before the international agreement in March 1935 Rhokana and Roan Antelope each produced about 6,000 tons of copper per month and Mufulira about 2,000 tons. Under the agreement the quotas specified were 5,376 tons for Rhokana and Roan Antelope and 2,986 tons for Mufulira for May 1935 and 4,704 and 2,613 tons, respectively, for June and thereafter. The construction programs at all three properties were to be continued as planned.[6]

U. S. S. R. (Russia).—Smelter production in 1934 increased about 14 percent over the previous year, but was short of expectations. The second 5-year plan, 1933–37, calls for the production of 155,000 metric tons of copper in 1937. The Urals contain about one fourth of the copper reserves of Russia and supply about three fourths of the current production, according to Riddell and Jermain, who have written on the copper resources of Russia.[7] Over 11,000 tons of copper were imported in 1934.

Yugoslavia.—Smelter production increased 8 percent. The Compagnie Française des Mines de Bor operate the only active deposits at present. Serious disturbances arose in the spring of 1935 over smelter fumes, necessitating troops to be sent to protect the Bor mining plant from being destroyed by local peasants. As this company is under contract with the Government of Yugoslavia it was not required to curtail output under the international agreement but will cooperate with other producers.

[6] South African Mining and Engineering Journal, Rhodesia and the Copper Restriction Scheme: Vol. 46, part 1, no. 2202, Apr. 13, 1935, p. 147.

[7] Riddell, Guy C., and Jermain, G. D., Russian Copper: Eng. and Min. Jour., December 1934, no. 12, vol. 135, pp. 547–551; February 1935, vol. 136, no. 2, pp. 82–87.

LEAD

By Elmer W. Pehrson and H. M. Meyer

SUMMARY OUTLINE

The lead industry of the United States remained in an unsatisfactory condition during 1934. Production again exceeded consumption so that there was further increase in stocks of refined lead. In consequence, the price trended downward throughout most of the year, from 4 cents per pound (New York) at the beginning to 3.70 cents at the close. The average was 3.86 cents compared to 3.87 cents in 1933. Production of refined primary lead increased 14 percent over 1933. The output of secondary lead, although 7 percent less than in 1933, continued to supply a very large part of the market. Consumption of primary and secondary lead increased 10 percent, mostly in uses associated with automobile manufacture and building activity. A small increase in the use of lead in cable covering ended a 4-year decline in this major outlet for lead. Stocks of refined pig lead increased 17 percent, but since there was a substantial decline in raw materials on hand and in process at refineries total stocks of lead increased only 6 percent. Production at the mines increased 5 percent in 1934.

Outside the United States consumption increased 17 percent, production increased 15 percent, and stocks of refined lead declined 13 percent, yet in spite of this marked improvement in the statistical position the London quotation for lead fell from 2.55 cents per pound (United States exchange basis) in January to 2.28 cents in December. This adverse price trend was attributed to the method of applying the British preferential tariff on lead by which small offerings of foreign lead unduly depressed the London Metal Exchange quotations. At the close of the year the situation was being studied by the British

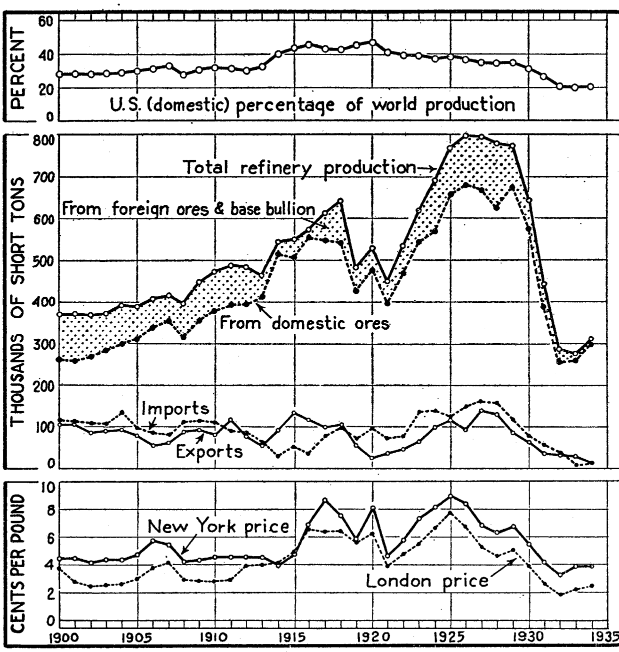

FIGURE 11.—Trends in the lead industry in the United States, 1900–34. Imports include lead in ore, base bullion, and refined; exports include refined lead and lead exported in manufactures with benefit of drawback. Imports shown for 1934 include lead imported for immediate consumption plus material entering the country under bond and are closely comparable to "general imports" shown for 1900–33.

Government. No attempt was made to revive the International Association of Lead Producers during the year, and the statistical service which had been continued after the collapse of the cartel by voluntary cooperation of the more important producers ended in October 1934.

The recovery in the lead industry outside the United States is in striking contrast to the recovery in the domestic industry. In 1934 consumption of lead in the United States equaled only 46 percent of the 1929 total, whereas elsewhere it slightly exceeded the 1929 level. Likewise domestic production was only 44 percent of the 1929 total while foreign production was over 90 percent.

Salient statistics of the lead industry in the United States, 1925–34

	1925–29 average	1930	1931	1932	1933	1934
Production of refined primary lead:						
From domestic ores......short tons..	660,525	573,740	390,260	255,337	259,616	299,841
From foreign ores and base bullion short tons..	123,104	69,293	52,504	33,024	13,963	11,395
	783,629	643,033	442,764	288,361	273,579	311,236
Recovery of secondary lead:						
As pig lead.................do....	126,600	129,000	128,800	128,000	131,800	124,500
In alloys...................do....	153,400	126,800	105,900	70,300	92,700	83,900
	280,000	255,800	234,700	198,300	224,500	208,400
Total production of pig lead (primary and secondary)..............short tons..	910,229	772,033	571,564	416,361	405,379	435,736
Imports: [1]						
Lead in base bullion..........do....	95,747	38,630	32,320	13,462	1,587	[1] 2,450
Lead in ore.................do....	40,096	39,377	20,888	21,001	5,958	[1] 10,611
Exports of refined pig lead.........do....	98,048	48,307	21,665	23,516	22,831	5,906
Refined primary lead available for consumption................short tons..	677,322	582,774	410,606	257,669	244,349	298,141
Estimated consumption of primary and secondary lead............short tons..	900,250	768,600	567,700	400,000	433,700	476,800
Prices per pound of refined lead at New York:						
Highest monthly average......cents..	10.33	6.25	4.80	3.75	4.50	4.18
Lowest monthly average.......do....	6.02	5.10	3.79	2.73	3.00	3.57
Average for year..............do....	7.47	5.52	4.24	3.18	3.87	3.86
Quotation at end of year.......do....	6.25	5.10	3.75	3.00	4.15	3.70
Mine production of recoverable lead short tons..	664,230	558,313	404,622	292,968	272,677	[2] 286,658
Southeastern Missouri district percent of total..	30	35	39	40	31	31
Utah.......................do....	23	21	20	21	22	20
Idaho......................do....	21	24	25	25	27	26
Joplin (Tri-State) region........do....	13	7	5	6	9	9
All other....................do....	13	13	11	8	11	14
World smelter production of lead metric tons..	1,678,000	1,696,000	1,386,000	1,160,000	1,151,000	[3] 1,322,000
United States.......percent of total..	38	33	27	22	21	21
Mexico......................do....	12	12	15	12	10	13
Australia....................do....	10	10	11	16	18	15
Canada......................do....	7	8	9	10	10	11
Spain.......................do....	9	7	8	9	8	6
All other....................do....	24	30	30	31	33	34

[1] Data for 1934 include lead imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given in the table for 1929–33.
[2] Subject to revision.
[3] Approximate production.

Lead industry and N. R. A.—The lead industry operated under the President's Reemployment Agreement until June 4, 1934, when a code of fair competition for the industry became effective. Details of this code were summarized briefly in last year's chapter of this series. To meet the labor provisions of the code wages were increased and hours of labor decreased in some sections of the country. In many sections, however, wage scales before the code was adopted equaled or exceeded the specified minimum. Since there has been no published report on activities of the code authority details of the first year's operation are not available at this time.

National Resources Board report on the lead industry.—The Planning Committee for Mineral Policy of the National Resources Board recommended the adoption of some means to prevent further accumulation of stocks and to reduce the present surplus to manageable proportions but concluded that specific plans should originate with the industry. For immediate consideration, however, it suggested (1) development of better statistics of secondary lead to supplement the market information services already available for this industry; (2) establishment of consumption forecasts, to be made by a Government agency, such as the Bureau of Mines, in cooperation with producers and organized consumers; and (3) joint action by the industry under public supervision to control the accumulation of excess stocks.

Effects of increased precious metal prices on lead mining.—The large increases in the prices of gold and silver in 1934 over 1933 increased

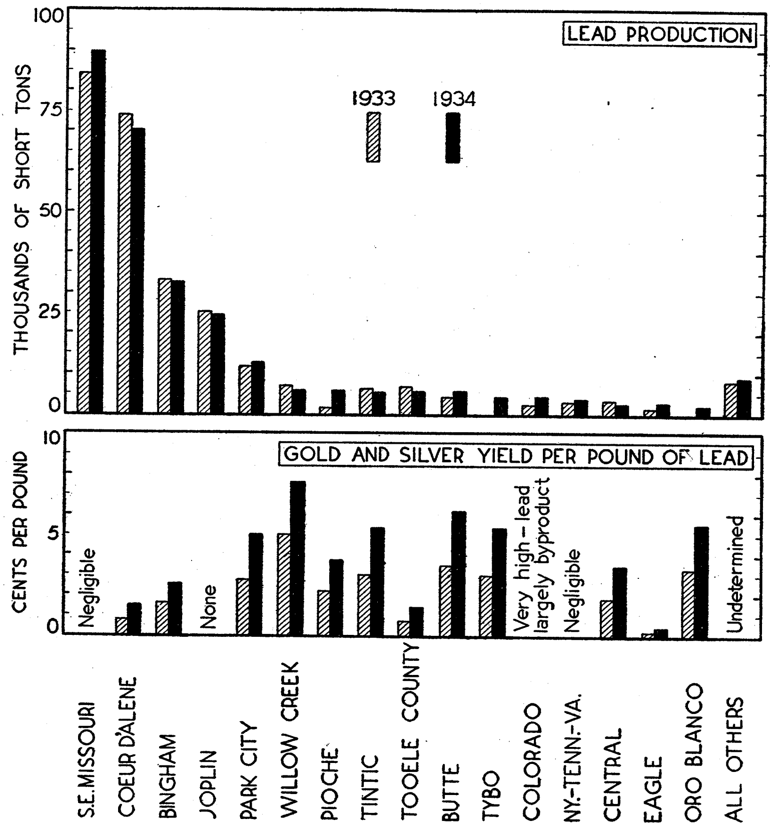

FIGURE 12.—Lead production and approximate gold and silver yield per pound of lead in the principal lead-producing districts, 1933–34. It is assumed that the gold and silver yield per pound of lead in 1934 was the same in quantity as for the latest previous year in which where was substantial production, in most cases 1933. Average prices used in computing yield were as follows: 1933, silver $0.35 and gold $25.56 per ounce; 1934, silver $0.6464+ and gold $34.95 per ounce. The average New York price of lead was 3.87 cents in 1933 and 3.86 cents in 1934. In Colorado, lead is obtained largely from ores mined for gold and silver, so that the precious metal yield per pound of lead is exceptionally high. The yield from ores in the miscellaneous districts included in "all others" was not shown, as it would represent merely an average of ores in which the precious-metal revenue per pound of lead varies greatly.

the precious metal revenue of lead producers in the United States by nearly $4,000,000. Since all the auriferous and argentiferous lead and lead-zinc ores are produced in the Western States virtually all of the increase in precious metal revenue was enjoyed by Western producers, thus improving their competitive position with producers in the Central and Eastern States. But the record for 1934 reveals that the total mine production of lead increased only 5 percent and that on the average the increase was shared fairly equally by districts that yield precious metals and those that do not (see fig. 12).

Closer examination of the record, however, reveals that higher precious metal prices induced considerable production of lead that otherwise might not have materialized in 1934. Thus operations were resumed at mines, idle in 1933, in the Tybo, Oro Blanco, and Philipsburg districts. Higher gold and silver prices probably were the principal factors that contributed to increased production in the Park City, Pioche, Butte, and Eagle districts. Large declines in some mines in the Bingham and Tintic districts and in Tooele County, Utah, were partly offset by increased production at other mines made possible by the rise in gold and silver revenue. There was a substantial increase in byproduct lead from gold and silver ores as can be seen from the following table which gives the production of lead by types of ores in 1933, with an estimate for 1934:

	1933	1934
	Short tons	*Short tons*
Lead ore	153,752	154,000
Lead-zinc ore	113,820	124,000
Gold and silver ore	3,704	7,400
Others	1,401	1,300
	272,677	286,700

The increase from gold and silver ores was due to increased activity at precious metal mines in Colorado and Utah, largely induced by higher gold and silver prices.

In some districts where gold and silver provide a very substantial part of the total revenue lead production declined. This may be accounted for by producers being able to mine lower-grade ores profitably as a result of higher precious metal prices, by exhaustion of some of the smaller mines, by voluntary curtailment to prevent further accumulation of stocks, by selective mining of ores containing higher gold and silver and lower lead values, and by selective mining of higher-zinc ores in lead-zinc mines induced by the relatively better price of zinc in 1934. Thus in the Willow Creek district where the precious metal revenue per pound of lead was over 7 cents in 1934 lead production declined substantially. Likewise declines in lead output were recorded in the Coeur d'Alene, Bingham, Tintic, and Central districts and in Tooele County. In all of these the gold and silver yield in 1934 exceeded 1 cent per pound of lead produced.

Enough time probably has not elapsed to gage the full effect of higher precious metal prices on lead mining. For the immediate future it seems reasonable to expect that the major part of any increase in consumption will be met by increased production in the Western States. This region, however, does not have potential production sufficient to meet any large increase in demand, so that as consumption returns to predepression levels adjustments will have to be made in the price of lead to permit economic operation of many nonprecious-metal-bearing lead mines. Meanwhile it cannot be denied that increased gold and silver prices have contributed to the increasing stocks of lead and have thus indirectly depressed lead prices. This obviously works to the detriment of those mines which contain little or no gold and silver.

DOMESTIC PRODUCTION

Refined pig lead produced in the United States is derived from three main sources—domestic ore, foreign ore and base bullion, and secondary materials. The following table shows the production from each of these sources from 1925 to 1934.

Total pig lead produced in the United States, 1925–34, short tons

Year	From domestic ores and base bullion	From foreign ores and base bullion	From secondary materials	Total
1925	654, 921	112, 048	112, 420	879, 389
1926	680, 685	118, 256	125, 000	923, 941
1927	668, 320	128, 210	119, 000	915, 530
1928	626, 202	154, 869	138, 000	919, 071
1929	672, 498	102, 135	138, 500	913, 133
1930	573, 740	69, 293	129, 000	772, 033
1931	390, 260	52, 504	128, 800	571, 564
1932	255, 337	33, 024	128, 000	416, 361
1933	259, 616	13, 963	131, 800	405, 379
1934	299, 841	11, 395	124, 500	435, 736

PRIMARY LEAD

Refinery production.—Production of refined primary lead in 1934 increased 14 percent and was equivalent to the normal production at the close of the nineteenth century. Production from foreign ores and base bullion declined 18 percent and was the lowest since 1886, the first year in which lead production from foreign raw materials was reported. Lead derived from domestic ores increased 15 percent in 1934.

Refined primary lead produced in the United States, 1929–34

Year	Production (short tons)				Sources (short tons)			Value	
	Desilverized lead [1] [2]	Desilverized soft lead	Soft lead [2]	Total production [1]	From domestic ores and base bullion	From foreign ores	From foreign base bullion	Average per pound	Total
1929	483, 622	55, 666	235, 345	774, 633	672, 498	29, 675	72, 460	$0. 063	$97, 604, 000
1930	396, 094	45, 578	201, 361	643, 033	573, 740	34, 348	34, 945	. 050	64, 303, 000
1931	263, 919	40, 456	138, 389	442, 764	390, 260	22, 254	30, 250	. 037	32, 765, 000
1932	189, 707	35, 524	63, 130	288, 361	255, 337	21, 747	11, 277	. 030	17, 302, 000
1933	165, 791	22, 210	85, 578	273, 579	259, 616	7, 677	6, 286	. 037	20, 245, 000
1934	186, 468	22, 744	102, 024	311, 236	299, 841	10, 241	1, 154	. 037	23, 031, 000

[1] The lead content of antimonial lead is excluded (see p. 82).
[2] Desilverized soft lead is excluded.

Refined primary lead produced in the United States, 1929–34, by sources, in short tons

Source	1929	1930	1931	1932	1933	1934
Domestic ore	672,498	573,740	390,260	255,337	259,616	299,841
Foreign ore:						
Australia	5	3		30		115
Canada	9,499	14,369	3,816	3,797	3,472	2,514
Europe	28	41	43	4,491	2,600	45
Mexico	16,807	14,949	6,420	334	257	1,011
South America	3,285	3,476	2,299	2,631	1,348	4,028
Other foreign	51	1,510	9,676	10,464		2,528
	29,675	34,348	22,254	21,747	7,677	10,241
Foreign base bullion:						
Mexico	51,295	18,592	30,072	11,164	6,021	703
South America	21,165	16,353	178	113	265	451
	72,460	34,945	30,250	11,277	6,286	1,154
Total foreign	102,135	69,293	52,504	33,024	13,963	11,395
Grand total	774,633	643,033	442,764	288,361	273,579	311,236

Source of primary lead.—Of the total refined lead produced in 1934, 96.3 percent was derived from domestic ores, 3.3 percent from foreign ores, and 0.4 percent from foreign base bullion. Production from foreign ores increased 33 percent in 1934 owing to increased tonnages from Newfoundland, Peru, Chile, and Mexico. Smelting of Canadian and European (mostly Swedish) ores in 1934 declined. The production of refined lead from foreign base bullion decreased 82 percent in 1934, all due to lower production from Mexican bullion. In 1928 over 117,000 tons of Mexican bullion were refined in the United States; in 1934 less than 1,000 tons were treated. Details of the sources of lead derived from domestic ores are given in the section on mine production.

Soft lead.—Nonargentiferous lead ores of high purity, from which a soft lead can be produced without elaborate refining processes, are known as soft-lead ores. Most of the soft-lead ores produced in the United States are smelted into pig lead; but a substantial quantity is used each year in the manufacture of lead pigments, principally sublimed lead and leaded zinc oxide. About one-fifth of the pig lead produced from soft-lead ores is desilverized and used largely in the manufacture of white lead where high purity is required.

Soft lead produced in the United States from domestic ores, 1929–34, in short tons

Year	Soft pig lead			Soft lead recovered in pigments	Total soft lead	Total domestic lead [1]	Soft lead percentage of domestic lead
	Undesilverized	Desilverized	Total				
1929	235,345	55,666	291,011	9,429	300,440	696,678	43
1930	201,361	45,578	246,939	6,686	253,625	588,042	43
1931	138,389	40,456	178,845	5,722	184,567	399,610	46
1932	63,130	35,524	98,654	4,932	103,586	263,846	39
1933	85,578	22,210	107,788	6,875	114,663	270,649	42
1934	102,024	22,744	124,768	7,538	132,306	313,280	42

[1] Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in pigments. Domestic lead in antimonial lead computed on different basis beginning with 1931. (See following table.)

Antimonial lead.—Antimonial lead or hard lead is an important byproduct of the refining of base bullion, but the amount derived from this source is only a small part of the country's yearly production. The major part is derived from the smelting of antimonial lead scrap, and some is produced by mixing metallic antimony with refined soft lead.

Several lead-smelting plants operate on scrap materials exclusively. Production data from such plants are summarized in the chapter on Secondary Metals. A large quantity of hard lead scrap also is treated at primary smelters and refineries, and the production of antimonial lead at these plants is shown in the table that follows.

Antimonial lead produced at primary lead refineries, 1929–34

Year	Production (short tons)				Antimony content		Lead content by difference (short tons)			
	From domestic ore	From foreign ore	From scrap	Total	Short tons	Percentage	From domestic ore	From foreign ore	From scrap	Total
1929	17,062	8,607	17,575	43,244	4,935	11.4	(1)	(1)	(1)	38,309
1930	8,918	4,793	11,086	24,797	2,967	12.0	(1)	(1)	(1)	21,830
1931	(2)	(2)	(2)	21,842	2,438	11.2	3,628	1,603	14,173	19,404
1932	(2)	(2)	(2)	21,024	2,495	11.9	3,577	1,466	13,486	18,529
1933	(2)	(2)	(2)	17,805	1,720	9.7	4,158	791	11,136	16,085
1934	(2)	(2)	(2)	16,607	2,263	13.6	5,901	330	8,113	14,344

[1] Not recorded. [2] Segregation discontinued.

SECONDARY LEAD

Secondary lead is increasing steadily in importance as a source of supply for industry. In 1909, the first year for which adequate data are available, production of secondary lead amounted to less than 42,000 tons and was equivalent to only 12 percent of the domestic primary lead output. During the next two decades production of secondary lead increased steadily and more rapidly than that of primary lead. By 1929 it had reached a peak of 311,000 tons, equal to 46 percent of the primary output. During the depression the decline in secondary production has been much less pronounced than in primary production, so that by 1933 the proportion had reached 86 percent. In 1934 a 7-percent decline in secondary output and a concomitant increase of 15 percent in primary output brought the proportion down to 70 percent.

Secondary lead recovered in the United States, 1929–34 [1]

Year	Pig lead (short tons)—			Lead in alloys (short tons)	Total recovered lead		
	At primary plants	At secondary plants	Total		Short tons	Value	Ratio to domestic refined primary lead (percent)
1929	65,359	73,141	138,500	172,500	311,000	$39,186,000	46
1930	48,135	80,865	129,000	126,800	255,800	25,580,000	45
1931	43,774	85,026	128,800	105,900	234,700	17,367,800	60
1932	33,611	94,389	128,000	70,300	198,300	11,898,000	78
1933	41,632	90,168	131,800	92,700	224,500	16,613,000	86
1934	33,557	90,943	124,500	83,900	208,400	15,421,600	70

[1] Compiled by J. P. Dunlop, of the Bureau of Mines.

The large return of secondary lead is due to the fact that a major part of the metal consumed each year goes into nondestructive uses and eventually returns to the smelter for reworking and reuse. Typical of such uses are cable coverings, plumbing, type metal, bearing metal, and most important of all, automobile storage batteries. At present, one-half or more of the secondary lead recovered is derived from discarded storage batteries, and the rapid increase in this source of scrap was the principal factor contributing to the rise in secondary lead production before the depression. Likewise the constancy of the supply of battery scrap has aided in maintaining the production of secondary lead during the depression.

From 1909 to 1918 the growth of secondary lead production was relatively slow. Although the use of storage batteries in automobiles began before the war it was not until 1921 that the battery was adopted widely as standard equipment; consequently, the return of

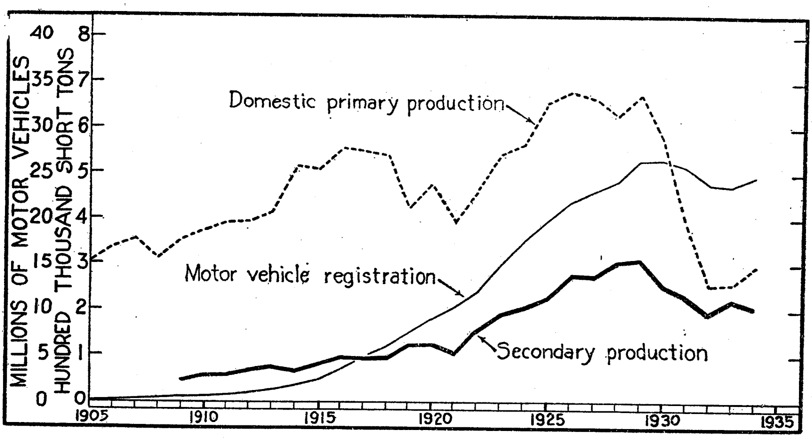

FIGURE 13.—Trends in production of primary and secondary lead and the number of motor vehicles in use in the United States, 1905–34. A large part of the secondary lead is derived from worn-out storage batteries, and since there has been a relatively small decline in the total number of motor vehicles in use this scrap supply has been maintained relatively well and has been available at prices prevailing during the depression. This accounts largely for the small decline in production of secondary lead compared with primary lead.

large amounts of battery scrap had not materialized by 1918. In 1919, however, there was a substantial rise in secondary production probably due to a sharp increase in the supply of battery scrap, collection of which had been induced by the high lead prices of 1917 and 1918. The new trend was temporarily interrupted by the business recession of 1920–21, but from 1921 to 1929 the increase in the supply of battery scrap resulting from the phenomenal rise in the number of automobiles in use is reflected in the rapid rise in secondary lead production.

At present the collection of discarded batteries is well-organized owing to the universal practice of battery dealers to accept old batteries as trade-ins on new ones; thus the supply of scrap moves fairly regularly to the smelters and is affected by changes in lead prices only to a minor extent. Since the number of automobiles in operation decreased only slightly during the depression the supply of battery scrap has continued at relatively high levels. It has been affected adversely, however, by the tendency of owners to delay replacements during hard times, a fact evidenced by the increase in the average life of a battery from about 2 years in 1928 and 1929 to 2.7 years in 1932. Since then it has declined again to 2.2 years in 1934. Another adverse factor has been the decrease in the quantity of lead used per battery, which fell from 29 pounds in 1928 to 24 pounds in 1934. Thus, while the total number of motor vehicles in use only dropped from 26,616,000 in 1929 to 24,933,000 in 1934 (6 percent) the supply of lead and antimony in battery scrap fell 27 percent—from 153,000 tons in 1929 to 111,000 tons in 1934, according to estimates of the American Bureau of Metal Statistics. Since lead constitutes 96 percent or more of the above tonnages the lead derived therefrom was equivalent to approximately half of the total secondary lead production.

LEAD PIGMENTS

Lead pigments manufactured in 1934 contained 165,211 tons of lead from the sources shown in the following table. Of this total about 157,294 tons were derived from refined pig lead, of which white lead accounted for 41 percent, litharge 42 percent, red lead 16 percent, and sublimed lead and orange mineral 1 percent. Sublimed lead and leaded zinc oxide are the principal pigments in which the lead content is derived from ores.

Lead in pigments,[1] 1929–34, by sources, in short tons

Year	Lead in pigments from—				Year	Lead in pigments from—			
	Domestic ore [2]	Metal	Scrap	Total		Domestic ore [2]	Metal	Scrap	Total
1929	9,429	248,657	2,427	260,513	1932	4,932	127,318	262	132,512
1930	6,686	190,182	689	197,557	1933	6,875	143,027	56	149,958
1931	5,722	166,328	710	172,760	1934	7,538	157,294	379	165,211

[1] Includes also lead recovered in zinc oxide and leaded zinc oxide.
[2] No pigments from foreign ore.

Further details on the production of lead pigments are given in the chapter on Lead and Zinc Pigments and Zinc Salts.

MINE PRODUCTION

Mine production of recoverable lead in 1934 was nearly 286,700 tons, an increase of 5 percent over 1933; it was 57 percent below the average for 1925 to 1929. Production in the Western States increased 6 percent, in the Central States 4 percent, and in the Eastern States 16 percent.

Compared with the 5-year average for 1925–29 production in 1934 was as follows: Western States, 45 percent; Central States, 40 percent; and Eastern States, about 89 percent. Missouri continued to rank first in production and increased 6 percent in output. Idaho ranked second and Utah third, but decreased 5 and 1 percent, respectively, in output. These three States contributed 77 percent of the total output in 1934. Nevada, Montana, Kansas, Colorado, and Arizona produced more lead in 1934 than in 1933, whereas Oklahoma, New Mexico, and Alaska produced less. The output of all important lead-producing States in 1934, except Nevada and New Mexico, was far below the 5-year predepression average.

Mine production of recoverable lead in the United States, 1925–34, in short tons

State	1925–29 average	1930	1931	1932	1933	1934
Western States and Alaska:						
Alaska	982	1,365	1,661	1,261	1,157	[1] 875
Arizona	9,743	4,246	982	1,182	1,721	[1] 3,300
California	2,070	1,780	1,879	1,209	381	412
Colorado	30,112	22,130	6,884	2,150	2,402	4,218
Idaho	141,610	134,058	99,365	72,118	74,363	[1] 71,000
Montana	18,871	10,653	4,430	1,079	6,582	[1] 9,900
Nevada	9,807	11,529	7,930	440	2,303	[1] 10,750
New Mexico	6,730	10,378	11,269	10,114	11,043	9,365
Oregon	6	5	2	4	5	21
South Dakota	21	--------	--------	4	--------	--------
Texas	213	198	--------	17	3	360
Utah	149,509	115,495	79,212	62,776	58,688	58,077
Washington	1,323	576	1,386	921	840	291
Wyoming	--------	--------	--------	5	--------	1
	370,997	312,413	215,000	153,280	159,488	[1] 168,570
Central States:						
Arkansas	38	53	78	4	10	40
Illinois	552	248	205	31	240	40
Kansas	26,121	12,910	7,082	6,490	6,089	6,805
Kentucky	135	101	--------	--------	176	104
Missouri	202,240	199,632	160,121	117,159	84,980	90,493
Oklahoma	58,306	23,052	13,210	10,634	18,038	16,747
Wisconsin	1,745	1,537	952	910	540	234
	289,137	237,533	181,648	135,228	110,073	114,463
Eastern States:						
New York	--------					
Tennessee	4,096	8,367	7,974	4,460	3,116	3,625
Virginia						
	4,096	8,367	7,974	4,460	3,116	3,625
	664,230	558,313	404,622	292,968	272,677	[1] 286,658

[1] Subject to revision.

Mine production of recoverable lead in the principal lead-producing districts of the United States, 1929–34, in short tons

District	State	1929	1930	1931	1932	1933	1934
Southeastern Missouri region.	Missouri	197,435	198,622	158,950	116,152	83,970	89,580
Coeur d'Alene region	Idaho	141,558	129,311	97,771	71,505	73,926	[1] 70,150
Bingham	Utah	49,447	42,586	33,597	32,610	33,030	32,420
Joplin region	Kansas, Missouri, Oklahoma.	74,143	36,972	21,463	18,131	25,137	24,465
Park City region	Utah	42,570	30,875	17,368	12,653	11,557	12,360
Willow Creek	New Mexico	5,720	5,431	7,563	6,449	7,075	6,143
Tintic	Utah	44,113	29,474	18,427	9,842	6,433	5,715
Rush Valley	do	11,751	10,157	8,773	7,222	6,916	5,594
Butte	Montana	8,239	2,540	--------	1	4,185	[1] 5,393
Central	New Mexico	3,766	3,936	3,420	3,521	3,408	2,846
Eagle	Montana	--------	1,287	3,489	771	1,521	(2)
Ophir	Utah	25	18	(3)	2	87	1,349
Leadville	Colorado	5,172	6,808	1,470	76	505	524
San Juan Mountains	do	17,386	11,722	908	792	906	1,651
Inyo County	California	670	1,711	1,765	1,102	301	277
Metaline	Washington	328	267	1,257	682	722	237
Upper Mississippi Valley	Iowa, northern Illinois, Wisconsin.	1,536	1,537	952	910	540	234
Banner	Arizona	2,938	929	--------	--------	385	(2)
Pend d'Oreille	Idaho	863	956	1,020	576	309	(2)
Bisbee (Warren)	Arizona	1,020	151	252	431	(3)	(2)
Eagle County	Colorado	198	2,821	3,816	221	8	52
Barker	Montana	6,137	4,578	21	--------	28	(2)
Warm Springs	Idaho	1,507	1,793	37	--------	21	(2)
Cedar Plains	Montana	1,177	120	25	2	1	(2)
Dome	Idaho	1,870	829	--------	1	--------	(2)
Tybo	Nevada	1,991	3,622	4,083	--------	(3)	(2)
San Francisco	Utah	691	1,883	436	--------	--------	--------
Austinville [4]	Virginia	(3)	(3)	(3)	(3)	(3)	(3)
Jack Rabbit [4]	Nevada	2,430	1,464	240	(3)	(3)	(2)
Oro Blanco [4]	Arizona	(3)	(3)	--------	--------	--------	(2)
Pioche [4]	Nevada	2,986	4,868	2,892	(3)	(3)	(2)
St. Lawrence County [4]	New York	--------	(3)	(3)	(3)	(3)	(3)

[1] Subject to revision.
[2] Data not available.
[3] Bureau of Mines not at liberty to publish figures.
[4] Not listed according to rank.

STOCKS

Lead stocks, as reported by the American Bureau of Metal Statistics, are shown in the following table. Stocks of refined and antimonial lead include metal held by all primary refiners and most of the refiners of secondary material that produce common lead. Foreign lead refined in the United States and entered for domestic consumption is included. During the past 6 years stocks of refined pig lead have increased steadily. At the close of 1934 they were nearly 5.4 times the amount held at the close of 1929. Combined stocks of refined and antimonial lead on December 31, 1934, exceeded a 7-month supply at the average rate of consumption in 1934. Stocks of unrefined lead on hand and in process at smelters declined in 1934.

Lead stocks at end of year at smelters and refineries in the United States, 1929–34, in short tons

	1929	1930	1931	1932	1933	1934
Refined pig lead	41,726	95,524	147,466	164,722	191,624	223,593
Antimonial lead	9,350	7,723	4,187	11,435	11,437	10,437
	51,076	103,247	151,653	176,157	203,061	234,030
Lead in base bullion:						
At smelters and refineries	8,313	8,171	12,952	13,911	12,786	6,045
In transit to refineries	7,116	4,261	2,971	1,302	2,191	1,528
In process at refineries	16,089	14,368	10,228	10,720	10,403	11,567
	31,518	26,800	26,151	25,933	25,380	19,140
Lead in ore and matte and in process at smelters	28,299	28,697	40,185	61,206	67,263	60,699
	110,893	158,744	217,989	263,296	295,704	313,869

According to the annual review of the British Metal Corporation stocks of refined lead outside the United States declined in 1934 from 330,000 short tons on January 1 to 286,000 tons on December 31. The former figure represents a downward revision of 45,000 tons in their estimate given a year ago (375,000 tons). On the basis of the revised figure world stocks may be estimated to have declined from 533,000 to 520,000 tons. Normally, world stocks amount to approximately 200,000 tons.

DOMESTIC CONSUMPTION

New supply.—The following table shows the refined primary lead available for consumption from 1929 to 1934. The computation does not take into account changes in producers' stocks, and as these have increased steadily during the past 6 years the quantities shown overstate actual consumption of new lead. Nevertheless, the supply available for consumption in 1934 was equivalent to only 43 percent of that in 1929.

Refined primary pig lead available for consumption in the United States, 1929–34, in short tons

	1929	1930	1931	1932	1933	1934
Supply:						
Stock in bonded warehouse Jan. 1	4,139	1,328	(1)	(1)	(1)	(1)
Imports of pigs, bars, and old	1,658	209	10	44	109	283
Production	774,633	643,033	442,764	288,361	273,579	311,236
	780,430	644,570	442,774	288,405	273,688	311,519
Withdrawn:						
Exports:						
Pig lead	73,251	48,307	21,665	23,516	22,831	5,906
In manufactures, with benefit of drawback	13,086	12,161	10,503	7,220	6,508	7,472
Stock in bonded warehouse Dec. 31	1,328	(1 2)	(1)	(1)	(1)	(1)
	87,665	61,796	32,168	30,736	29,339	13,378
Supply available for consumption	692,765	582,774	410,606	257,669	244,349	298,141

[1] Stocks of pigs, bars, etc., in bonded warehouse not separately recorded after April 1930 but included with base bullion. (See table on p. 91.)
[2] For purpose of calculating quantity available for domestic consumption, stocks in warehouse are estimated to have remained unchanged from the beginning of the year.

Consumption by uses.—Owing to the large return of secondary lead from the lead-consuming industries the total consumption of pig lead greatly exceeds the supply of new lead available. The following table gives the American Bureau of Metal Statistics estimate of the total consumption of lead by industries during the past 6 years.

Lead consumed in the United States,[1] in 1929–34, in short tons

Purpose	1929	1930	1931	1932	1933	1934
White lead	119,700	83,900	77,500	54,500	59,100	64,500
Red lead and litharge	30,000	32,000	18,000	15,800	19,000	28,000
Storage batteries	210,000	163,000	157,000	138,000	147,000	163,000
Cable covering	220,000	208,000	117,000	55,000	31,000	34,100
Building	96,000	67,000	40,000	22,000	26,000	30,000
Automobiles	18,000	11,000	6,000	3,500	5,000	7,300
Railway equipment	5,700	5,200	1,000	300	200	800
Shipbuilding	300	500	400	200	100	200
Ammunition	41,100	33,300	29,700	23,300	32,300	34,800
Terneplate	4,200	2,700	2,200	1,400	2,500	2,400
Foil	39,800	26,000	20,000	14,000	22,500	16,200
Bearing metal	33,000	20,000	12,000	10,000	15,000	16,500
Solder	37,000	27,000	20,500	14,000	16,000	16,000
Type metal	18,000	16,000	14,400	10,800	11,000	13,000
Calking	31,500	21,000	15,000	10,000	12,000	10,000
Castings	18,000	12,000	7,000	5,000	5,000	5,000
Other uses	50,000	40,000	30,000	22,200	30,000	35,000
	972,300	768,600	567,700	400,000	433,700	476,800

[1] Source: American Bureau of Metal Statistics. These estimates are for the total consumption of lead irrespective of whether its origin be primary or secondary. Antimonial lead is included.

The industrial use of lead increased 10 percent in 1934 but still was 51 percent below the 1929 record. Factors contributing to the increase in 1934 included the 43-percent rise in automobile manufacture and the 23-percent increase in building construction. Storage batteries continued to be the largest consumer of lead, increasing 11 percent in 1934. Although this outlet for lead is influenced by the number of new automobiles produced the major market is in replacements in old cars. Out of a total of 12,900,000 automobile batteries manufactured in 1934, 10,121,000 went into replacements. The total number of automobiles registered in 1934 was 24,933,000, an increase of 5 percent over 1933. To the increase in new automobile production, however, may be attributed the increase in the direct use of lead in automobiles and a portion of the increase assigned to bearing metals.

Consumption of lead in cable covering, normally the largest use of lead, increased slightly in 1934 but was still at very low levels. This was due largely to the sharp decline in the manufacture of telephone cable during the depression.

The revival in construction activity is reflected in the increased use of lead directly in building and in the manufacture of white lead and red lead, which are used largely in paint manufacture. White lead formerly was the principal use of lead and over a decade ago accounted for approximately 25 percent of the lead used in this country. Owing to competition from zinc and titanium pigments, however, its relative importance has decreased to only 14 percent in 1934. The use of lead in ammunition increased again in 1934, whereas lead foil and calking declined substantially. Under "other uses" the largest item in recent years has been the manufacture of tetraethyl lead, which has been increasing rapidly. Compared with 1929 the quantity of lead used in the six principal consuming industries in 1934 was as follows: Storage batteries, 78 percent; white lead, 54 percent; ammunition, 85 percent; cable covering, 16 percent; building, 31 percent; and red lead and litharge, 93 percent.

PRICES

The two major markets for lead in the United States are New York and St. Louis; a large part of the lead produced in the United States is sold at prices based on quotations in these markets. The New York quotations are influenced to some extent by the lower prices usually prevailing on the London market, so that the New York price seldom exceeds the St. Louis price by as much as the freight differential, normally 0.35 cent a pound.

The price of lead in 1934 was slightly lower than in 1933. The average New York quotation was 3.86 cents per pound compared with 3.87 cents in 1933; it was 43 percent below that of 1929. At the beginning of 1934 the price was 4 cents. This quotation was maintained until early in April, when anticipation of higher prices expected as a result of pending approval of the Lead Code and the general improvement in business stimulated a buying wave which brought the quotation up to 4.25 cents. During the latter part of May, however, the downward trend, which began in October 1933 after the inflationary rise in the summer of that year, was resumed and maintained until a low for the year of 3.5 cents was reached during the latter part of November and the first half of December. The quotation at the close of the year was 3.7 cents. The large increase in lead stocks in 1934 and the weakness of the London market affected the domestic price unfavorably in 1934.

The London quotation for 1934 (United States exchange basis) averaged 2.46 cents per pound—1.4 cents below the New York average. Owing to more settled exchange conditions the differential between New York and London was maintained within relatively narrow limits. The London quotations, which declined from £11.304 in January to £10.317 in December, did not reflect a substantial improvement in the statistical position abroad. It was claimed that the method of applying the 10-percent preferential tariff on British lead made it possible for small offerings of foreign lead to depress unduly the London market.

Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1932–34, in cents per pound [1]

Month	1932			1933			1934		
	St. Louis	New York	London	St. Louis	New York	London	St. Louis	New York	London
January	3.55	3.75	2.31	2.87½	3.00	1.57	3.90	4.00	2.55
February	3.51	3.72	2.25	2.87½	3.00	1.59	3.90	4.00	2.61
March	2.99	3.15	2.01	3.03	3.15	1.63	3.90	4.00	2.63
April	2.90	3.00	1.88	3.13	3.27	1.74	4.05	4.18	2.65
May	2.90	3.00	1.75	3.52	3.65	2.12	3.99	4.14	2.52
June	2.89	2.99	1.56	4.02	4.17	2.45	3.82	3.98	2.49
July	2.59	2.73	1.56	4.30	4.45	2.78	3.63	3.77	2.43
August	3.09	3.24	1.76	4.35	4.50	2.45	3.60	3.75	2.45
September	3.32	3.46	2.03	4.35	4.50	2.49	3.54	3.69	2.32
October	2.94	3.06	1.81	4.18	4.32	2.46	3.51	3.66	2.28
November	2.93	3.05	1.77	4.14	4.29	2.65	3.42	3.57	2.32
December	2.88	3.00	1.63	4.04	4.14	2.61	3.45	3.60	2.28
Average	3.04	3.18	[2] 1.86	3.74	3.87	[2] 2.21	3.73	3.86	[2] 2.46

[1] St. Louis: Metal Statistics, 1935, p. 373. Average daily quotations of soft Missouri lead, f. o. b. St. Louis (open market), as reported daily in the American Metal Market.
New York: American Metal Market, daily issues. Pig lead, New York (outside market), prompt shipment from West.
London: Metal Statistics, 1935, p. 377. Average price of foreign lead. Price per long ton, as published in Metal Statistics, converted to cents per pound at average exchange rate reported by the Federal Reserve Board.
[2] London quotations in pounds sterling per long ton, as follows: 1932, £11.913; 1933, £11.6708; 1934, £10.9333.

FOREIGN TRADE [1]

The foreign trade of the United States in lead consists largely of imports of ore and base bullion, which are smelted and refined in bond, and the export of this lead either as refined lead or in manufactured products. Since 1927, however, this trade has declined. In 1934 only 13,344 tons of lead in ore and base bullion (including a small amount of refined and scrap lead) were imported compared with 161,389 tons in 1927; exports of refined lead decreased from 125,267 to 5,906 tons. During the same period lead exported in manufactures with benefit of drawback declined from 12,004 to 7,472 tons.

Imports.—Total imports of lead in ore and matte, including imports for immediate consumption and entries for warehouse, increased 78 percent in 1934 due to increased shipments from Newfoundland, Peru, Chile, and Mexico. Receipts from Canada were considerably less, and there was no intake of Swedish ores in 1934. Imports of base bullion increased 54 percent, most of the increase being larger shipments from Mexico. Imports of refined lead were negligible. Total imports of lead increased 74 percent but were equivalent to less than 12 percent of the 1929 total.

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Total lead imported into the United States, 1929–34, by classes, in short tons [1]

Year	Lead in ore and matte	Lead in base bullion	Pigs, bars, sheets, and old	Total lead content
1929	31, 331	83, 071	1, 657	116, 059
1930	39, 377	38, 630	209	78, 216
1931	20, 888	32, 320	[2] 10	53, 218
1932	21, 001	13, 462	44	34, 507
1933	5, 958	1, 587	109	7, 654
1934	10, 611	2, 450	283	13, 344

[1] Data for 1934 include lead imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given in the table for 1929–33.
[2] Reclaimed scrap, etc. No imports of pigs, bars, etc., were recorded for 1931.

Total lead imported into the United States, in ore, base bullion, and refined, 1929–34, by sources, in short tons [1]

Year	Canada	Mexico	Newfoundland	South America	Europe	Other countries	Total
1929	4, 512	87, 936	----------	23, 526	14	71	116, 059
1930	17, 268	36, 721	----------	22, 472	113	1, 642	78, 216
1931	2, 618	38, 706	9, 708	2, 171	----------	15	53, 218
1932	2, 459	13, 545	10, 598	2, 811	5, 053	41	34, 507
1933	1, 629	2, 154	----------	1, 485	2, 368	18	7, 654
1934	1, 160	3, 270	3, 357	5, 455	67	35	13, 344

[1] Data for 1934 include lead imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given in the table for 1929–33.

Total lead imported into the United States, in ore and m atte, 1929–34, by countries in short tons [1]

Country	1929	1930	1931	1932	1933	1934
Canada	3, 953	17, 257	2, 614	2, 459	1, 629	902
Chile	2, 295	3, 313	1, 866	2, 211	651	1, 443
Mexico	23, 415	16, 341	6, 495	195	862	1, 283
Newfoundland and Labrador	(2)	----------	9, 708	10, 598	----------	3, 357
Peru	1, 601	831	194	477	522	3, 545
Sweden	----------	----------	----------	5, 024	2, 292	----------
Other countries	67	1, 635	11	37	2	81
	31, 331	39, 377	20, 888	21, 001	5, 958	10, 611

[1] Data for 1934 include lead in ore and matte imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given in the table for 1929–33.
[2] Less than 1 ton.

Total lead imported into the United States, in base bullion, 1929–34, by countries, in short tons [1]

Country	1929	1930	1931	1932	1933	1934
Mexico	63, 458	20, 350	32, 210	13, 340	1, 281	1, 987
Peru	19, 605	18, 280	110	121	306	463
Other countries	8	----------	----------	1	----------	----------
	83, 071	38, 630	32, 320	13, 462	1, 587	2, 450

[1] Data for 1934 include lead in base bullion imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given in the table for 1929–33.

Lead remaining in warehouses in the United States, December 31, 1929–34, in short tons

[Stated in the form in which the material was entered for warehouse]

Year	Lead in ore and matte	Lead in base bullion	Pigs, bars, sheets, and old	Year	Lead in ore and matte	Lead in base bullion	Pigs, bars, sheets, and old
1929	60,207	75,434	1,328	1932	42,314	[1] 3,769	(1)
1930	39,516	[1] 5,642	(1)	1933	21,540	[1] 1,058	(1)
1931	52,849	[1] 5,343	(1)	1934	15,709	[1] 606	(1)

[1] Pigs, bars, and old included with base bullion; not recorded separately for 1930–34.

Imports of consumption decreased in value in 1934 owing to the large decline in withdrawals of lead in the form of ore and matte. Imports of base bullion for consumption increased materially.

Lead imported for consumption in the United States, 1929–34, by classes

Year	Lead in ore and matte [1]		Lead in base bullion		Pigs, bars, and old		Sheets, pipe, and shot		Not otherwise specified	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1929	10,823	$1,160,533	6,198	$627,455	10,089	$1,052,087	450	$78,776	$126,966	$3,045,817
1930	15,458	1,461,350	10,423	1,127,920	571	60,493	454	78,737	87,612	2,816,112
1931	10,734	1,194,191	10,436	671,002	[2] 10	[2] 1,763	428	60,536	49,990	1,977,482
1932	9,647	863,135	2,574	131,579	44	2,031	543	53,510	14,848	1,065,103
1933	19,239	1,154,093	306	31,700	45	2,199	518	45,378	13,578	1,246,948
1934	10,760	558,558	2,220	117,729	285	10,678	286	35,130	12,940	735,035

[1] Classification as follows: Jan. 1, 1929, to June 17, 1930, "Lead in ore and matte"; June 18, 1930, through 1934, "Lead in ores, flue dust, and mattes, n. s. p. f."
[2] Reclaimed scrap, etc. No imports of pigs, bars, etc., recorded for 1931.

Miscellaneous products containing lead imported for consumption in the United States, 1929–34

Year	Babbitt metal, solder, white metal, and other combinations containing lead			Type metal and antimonial lead		
	Gross weight (short tons)	Lead content (short tons)	Value	Gross weight (short tons)	Lead content (short tons)	Value
1929	1,505	663	$777,354	2,720	2,425	$180,679
1930	1,399	530	593,103	328	275	32,934
1931	906	310	436,574	----------	----------	----------
1932	498	191	143,662	6	5	479
1933 [1]	349	51	30,623	25	21	1,076
1934 [1]	709	102	71,505	112	94	6,784

[1] Imports of antimonial pig containing about 14 percent lead formerly was included with "type metal and antimonial lead." In 1934 the Bureau of Foreign and Domestic Commerce included it with "babbitt metal, solder, white metal, etc."; the 1933 figures are revised to comparable basis with 1934.

Exports.—Exports of refined lead declined 74 percent in 1934 and were equivalent to only 6 percent of the average from 1925 to 1929. The decline in 1934 was due largely to the loss of markets in Japan, which increased its purchases from Mexico, Canada, India, and Australia.

Foreign lead exported in manufactures with benefit of drawback amounted to 7,472 tons, an increase of 15 percent over 1933. About 35 percent of the 1934 total was contained in storage batteries exported. Other lead exports included: Litharge and red lead, 16 percent; sheets, pipes, solder, etc., 15 percent; white lead, 12 percent; and electrical apparatus, 11 percent.

Refined lead exported from the United States, 1929–34

Year	Pigs, bars, and old		Foreign lead exported in manufactures with benefit of drawback (short tons)	Year	Pigs, bars, and old		Foreign lead exported in manufactures with benefit of drawback (short tons)
	Short tons	Value			Short tons	Value	
1929	73,251	$7,178,337	13,086	1932	23,516	$1,069,697	7,220
1930	48,307	3,904,213	12,161	1933	22,831	832,984	6,508
1931	21,665	1,241,881	10,503	1934	5,906	304,581	7,472

Refined pig lead exported from the United States, 1929–34, by destinations, in short tons

Destination	1929	1930	1931	1932	1933	1934
COUNTRY						
Argentina	599	934	226	----------	113	[1]
Brazil	1,538	874	1,382	759	329	475
Canada	141	9	58	133	6	21
France	2,202	3,001	318	224	----------	----------
Germany	9,745	823	52	1,344	5	----------
Japan	16,416	15,653	17,301	20,219	21,236	4,454
Mexico	83	40	171	13	5	21
Netherlands	1,522	22	13	112	----------	4
Philippine Islands	111	543	400	475	360	169
Sweden	7,255	7,557	392	----------	----------	----------
United Kingdom	23,732	9,157	3	----------	----------	36
Uruguay	448	364	145	84	140	----------
Other	9,459	9,330	1,204	153	637	726
	73,251	48,307	21,665	23,516	22,831	5,906
CONTINENT						
North America	693	318	435	160	41	107
South America	3,852	2,442	1,903	863	732	1,076
Europe	50,649	27,899	795	1,793	5	40
Asia	18,055	17,289	18,524	20,700	21,693	4,512
Africa and Oceania	2	359	8	----------	360	171
	73,251	48,307	21,665	23,516	22,831	5,906

[1] Less than 1 ton.

WORLD ASPECTS OF LEAD INDUSTRY

International cooperation.—No attempt was made during 1934 to revive the Lead Cartel, which went out of existence with the imposition of the British tariff on lead in 1932. The cooperative arrangement between the more important foreign producers, by which regular compilation of statistics had been continued after the collapse of the cartel, ended in October 1934 because one of the larger producers was unwilling to continue giving its figures.

World production.—World smelter production of lead increased 15 percent in 1934 but was equivalent to only 74 percent of the record output of 1929. Production increased 16 percent in the United States and 15 percent in the rest of the world. The United States was the leading producer and contributed 21.3 percent of the 1934 total, approximately the same as in 1933. The 10 other leading producing countries and the percentage of the world total each contributed in 1934 were as follows: Australia, 15.4; Mexico, 12.5; Canada, 10.8; Germany, 9.1; Belgium, 5.7; Spain, 5.6; India, 5.5; Italy, 3.1; Tunisia, 2.1; and U. S. S. R. (Russia), 2.0. In addition to the United States other important producers showed the following percentage increases: Mexico, 40; Canada, 24; Germany, 3; Belgium, 8; Italy, 68; Tunisia, 84; and U. S. S. R. (Russia), 97. Production in India was virtually unchanged, while that in Australia and Spain decreased 3 and 16 percent, respectively. Production in the British Empire amounted to about 434,000 metric tons in 1934, an increase of 8 percent over 1933 and 17 percent over the 5-year average 1925–29. The Empire's share of world output was 33 percent in 1934 compared with 22 percent from 1925 to 1929.

World production of lead, 1929–34, in metric tons [1]

[Compiled by L. M. Jones, of the Bureau of Mines]

Country [2]	1929	1930	1931	1932	1933	1934
Argentina	9,020	8,882	7,609	3,481	2,799	2,766
Australia	180,358	171,248	152,850	189,347	208,558	203,041
Austria	6,569	6,935	6,117	1,986	4,626	7,900
Belgium	82,850	85,370	70,850	64,160	69,390	(3)
Canada	138,095	138,105	126,301	114,820	115,469	142,635
Chosen	333	130	97	453	784	(3)
Czechoslovakia	4,609	4,225	3,569	4,124	3,811	(3)
France	20,358	20,170	19,100	12,000	7,711	17,360
Germany [4]	97,900	110,800	101,300	95,216	116,600	119,980
Great Britain	10,839	10,383	10,723	7,100	5,600	14,966
Greece	5,361	7,329	6,707	6,482	[5] 6,500	(3)
Hungary	109	70	52			(3)
India (Burma)	81,521	81,010	75,985	72,345	73,201	72,968
Indo-China	17	11	6	16	18	(3)
Italy	22,650	24,340	24,882	31,471	24,716	41,546
Japan	3,374	3,581	4,070	6,415	6,825	(3)
Mexico	239,952	242,537	210,427	137,099	118,460	165,416
Northern Rhodesia	1,661				74	187
Norway	[5] 300	[5] 300	347	435	365	(3)
Peru	19,448	14,979	252	327	[5] 300	(3)
Poland	35,789	40,900	31,380	11,902	12,065	10,350
Portugal	96	89	108	109	70	54
Rumania	565	984	1,314	1,938	4,082	(3)
South-West Africa [6]	2,802	3,661	2,641	1,044	408	(3)
Spain	142,753	123,263	109,630	105,370	88,354	74,021
Tunisia	18,850	19,400	19,112	14,082	14,873	27,311
Turkey	7,324	4,664	2,767		3,036	(3)
United States (refined) [7]	636,997	551,645	374,224	251,365	242,483	281,300
U. S. S. R. (Russia)	[8] 6,200	10,750	16,140	18,800	13,700	27,000
Yugoslavia	9,471	10,049	7,929	8,321	6,337	7,864
	1,786,000	1,696,000	1,386,000	1,160,000	1,151,000	[9] 1,322,000

[1] By countries where smelted but not necessarily refined.
[2] In addition to the countries listed China smelts lead, but no reliable data of output are available.
[3] Data not available.
[4] Exclusive of secondary material (Metallgesellschaft, Frankfurt).
[5] Approximate production.
[6] Year ended Mar. 31 of year following that stated.
[7] Figures cover domestic refined and lead refined from foreign ore; refined lead produced from foreign base bullion not included.
[8] Year ended Sept. 30.
[9] Approximate production based on output of countries shown, which in 1933 contributed about 92 percent of the total world output.

World consumption.—World consumption of lead in 1934 is estimated at 1,338,000 metric tons, an increase of 14 percent over 1933. The increase in the United States, after allowance for changes in stocks and including secondary and antimonial lead produced at primary refineries, was only 6 percent compared with 17 percent elsewhere. For the first time in many years the United States ranked second in lead consumption in 1934, having been surpassed by Great Britain, which took 25 percent of the total; the United States' share was less than 23 percent. Other important consumers and the proportion of the total each took were: Germany, 12 percent; France, 9 percent; Japan, 8 percent; Italy, 4 percent; U. S. S. R. (Russia) and Belgium, 3 percent each. These 8 countries consumed 87 percent of the total. Europe accounted for 64 percent of the total; North and South America, 25 percent; Asia, 9 percent; Australia, 1 percent; and Africa, less than half of 1 percent. Besides the United States other important consuming countries showed increases as follows: Great Britain, 22 percent; Germany, 15 percent; Japan, 39 percent; Italy, 44 percent; U. S. S. R. (Russia), 53 percent; and Belgium, 29 percent. France was the only important consumer to show a decline (17 percent) in 1934.

REVIEW BY COUNTRIES

Australia.—Smelter production of lead declined 3 percent from the record high of 1933, owing to declines in production at Mount Isa and Port Pirie.

At Mount Isa production was affected adversely by labor troubles at the beginning and by plant alterations at the close of the year. The total output of bullion was 42,638 long tons compared with 45,150 in 1933. Owing to the continued low price of lead the company had operated at a loss since the beginning of operations. For this reason it was decided to convert the plant to an all-sulphide ore basis to increase revenues. Previously it had operated largely on carbonate ores containing only lead and silver. The sulphide ores contain more silver and in addition to lead will yield zinc concentrates. Exploration showed that the ore body continued at depth and was richer than in the upper levels of the mine.

Broken Hill supplies the larger part of the Australian lead production. In all, 1,256,000 long tons of ore were treated in 1934, an increase of 55,000 tons over 1933. All four principal producers operated in 1934. Although there was a substantial increase in the production of lead concentrates the output of the smelter at Port Pirie declined slightly.

Exports of bullion and refined lead totaled 182,000 tons in 1934 compared with 194,000 tons in the previous year. Over 97 percent of the 1934 total went to Europe, principally Great Britain. About 28,000 tons of lead concentrates were exported in 1934, chiefly to Belgium and Italy.

Belgium.—Lead production in Belgium is derived from foreign ores and base bullion. In 1934, 97,000 metric tons of lead ore and 20,000 tons of metallic lead were imported. Newfoundland, Australia, Sweden, and Canada were the principal sources of ore, and Mexico supplied over 70 percent of the metal. More than 44,000 tons of refined pig lead were exported, of which 26,000 tons went to France. The proposed reciprocal trade agreement between Belgium and the United States reduces the import duty on white lead into the United States from 2.5 to 2.1 cents per pound.

Canada.—Mine production of lead in Canada in 1934 was 173,135 short tons, an increase of 30 percent over 1933. British Columbia supplied over 99 percent of the total and was responsible for all of the increase in 1934, as the output of Ontario and the Yukon Territory declined. The principal source of lead in British Columbia is the

Sullivan mine of the Consolidated Mining & Smelting Co., Ltd. A total of 1,745,992 tons of lead-zinc ore was mined, an increase of 24 percent over 1933. Nearly 222,000 tons of lead concentrates were produced compared with 172,000 tons in the previous year. The ore treated in 1934 contained more lead and silver and less zinc, and recoveries were slightly lower than in 1933. Costs of production were the lowest in the history of the company. The company's smelter at Trail is the only lead smelter in Canada. The Base Metals Mining Corporation, Ltd., shipped nearly 12,000 tons of 80-percent lead concentrates compared with less than 6,000 tons in 1933.

Exports of refined pig lead were slightly lower in 1934. A total of 141,579 tons was shipped abroad; Great Britain took 81,000 tons compared with 86,000 in 1933, and Japan 45,000 tons compared with 36,000 a year ago. In view of the large increase in smelter output the decline in exports indicates a substantial addition to lead stocks in Canada in 1934. Shipments of lead in the form of ore increased from 3,800 tons in 1933 to 11,800 tons in 1934; the United States took about 1,000 tons and Belgium 10,800 tons. Shipments to the United States were chiefly silver-lead concentrates from the Mayo district, Yukon, whereas those to Belgium were concentrates produced at the Monarch mine of Base Metals Mining Corporation, Ltd.

France.—France ranks fourth in lead consumption and depends largely on foreign lead for its supply. In 1934 consumption was 116,000 metric tons, a decrease of 17 percent from 1933. The domestic smelter output was only 17,360 tons. Imports of pig lead declined from 132,000 tons in 1933 to 99,000 tons in 1934. The principal sources in 1934 were: Mexico, 26 percent; Belgium, 26 percent; Spain, 21 percent; Tunis, 18 percent; and Greece, 6 percent. Shipments from Greece, which exceeded 6,000 tons, were argentiferous lead. France imported 26,000 tons of lead ore in 1934 compared with 18,000 tons in 1933. Exports of lead from France are relatively unimportant. Agitation for additional tariff protection for domestic and colonial mines continued during the year but no positive action was taken. During the latter part of the year the Penarroya company began construction of a 30,000-ton smelter at Noyelles-Godault in northern France. The plant will be supplied by imported ores.

Germany.—Metal consumption in Germany was increased greatly in 1934 as a result of the aggressive national rehabilitation program. Building activity increased 50 percent over 1933, the automotive industry reached an all-time peak, and repair, modernization, and extension of industrial plants was conducted on a large scale. As a result, lead consumption increased 15 percent in 1934 and amounted to 160,000 metric tons, the highest since 1930. This increase was met by a 3-percent rise in smelter output and an 83-percent advance in net imports of pig lead.

Imports of pig lead were 48,600 tons, approximately equal to the 1933 total. Mexico and Australia were the principal sources in 1934. Exports, however, declined from 27,000 tons in 1933 to 8,800 tons, and as the resulting large increase in net imports added to the critical position of Germany with respect to foreign credits imports were subject to rigid control during the latter half of the year. Increase in domestic mining activity permitted a decline in imports of lead ore from 105,000 tons in 1933 to 82,000 tons in 1934, the latter being derived largely from Yugoslavia and Newfoundland. Receipts of ore from Great Britain declined from 23,000 to 4,000 tons.

The desire of Germany to become self-sufficient with respect to supplies of metals resulted in the adoption in 1932 of a program of subsidies to the domestic mining industry. As this had not proved to be as effective as desired the program was liberalized greatly in 1934. Instead of being grants repayable from future earnings subsidies became direct grants and were increased to include a legitimate return on invested capital. The new program resulted in increased activity in lead mining during the latter part of 1934 and early in 1935.

Great Britain.—Apparent consumption of pig lead exceeded all previous records in 1934 as a result of the improvement in industrial activity. A total of 329,000 long tons was used, an increase of 22 percent over 1933. Smelter production more than doubled in 1934 but was less than 5 percent of the domestic needs. Imports increased 11 percent to 313,000 tons, of which Australia supplied 52 percent, Canada 24 percent, India 13 percent, and Mexico 5 percent. Stocks in official warehouses were reduced by 10,000 tons.

Mining of lead increased again in 1934. Statistics for the first 9 months of the year indicate a total output in excess of 65,000 tons of concentrates containing 80 percent lead compared with 49,056 tons in 1933. This ore formerly was exported to the Continent for smelting, but at the close of the year a 25,000-ton smelter was put into operation to treat ores from the Mill Close mine, which in 1933 supplied three-fourths of the total mine output.

The 10-percent tariff on non-British lead established in 1932 provoked dissatisfaction in 1934. It was claimed that the peculiar method of administering the tariff permitted small offerings of foreign metal to depress unduly quotations on the London Metal Exchange. Thus, in spite of the improved statistical position in Europe, the London price of lead trended downward during the year, reaching a low of £10 for spot metal in October. This was equivalent to less than £6 under the old gold standard. Owing to the large increase in consumption and the temporary shut-down of the Northfleet refinery due to the stoppage of shipments of base bullion from Mount Isa, supplies of Empire metal were scarce during most of the year, and consumers were forced to pay premiums for Empire metal. According to Brandeis, Goldschmidt & Co., Ltd., the premium averaged about 15 shillings per ton during the latter half of 1934. At the close of the year the Government initiated an inquiry into the import duty situation, but up to May 1, 1935 no report had been made.

Greece.—The Thracian Mineral Products, Ltd., of London, has contracted with the Greek Government to erect a lead smelter at Laurium within 2 years. The plant is to have capacity for handling 30,000 metric tons of ore and will be equipped to produce 5,000 tons of lead pigments annually. The plant will operate exclusively on Grecian ores.

India.—The Burma Corporation, Ltd., produced approximately 97,600 long tons of silver-lead concentrates averaging about 65 percent lead; 70,560 tons of refined lead, 1,255 tons of antimonial lead, and 5,792,019 ounces of silver were produced. Exploration in the lower levels of the Bawdwin mine indicated that the bottom of the ore body has been reached and that further extension of reserves will have to be found in the unexplored upper regions of the property. Exports of pig lead totaled 60,000 tons, a decrease of 7 percent from 1933. Shipments to Great Britain decreased 27 percent and those to Japan increased 78 percent.

Italy.—Lead consumption increased 44 percent in 1934 to 48,000 metric tons and was nearly equal to the predepression peak. This was accomplished entirely by a large increase (68 percent) in smelter output, as imports of the metal declined from 8,700 tons in 1933 to 6,100 in 1934. The substantial increase in production was accomplished largely by smelting foreign ores, imports of which rose from 17,800 tons in 1933 to 37,400 tons in 1934. Great Britain supplied 46 percent of the 1934 total and Australia 28 percent, both countries shipping larger tonnages than in 1933. Lead mining, which has been conducted under Government subsidy during the past few years, improved but little in 1934. A total of 30,000 tons of concentrates was produced, approximately the same as in 1933.

During the latter part of the year an import duty of 17 lire per quintal was imposed on lead ores. Early in 1935 it was reported that under a recently adopted system of import licenses the quota for pig lead had been fixed at 25 percent of the 1934 imports.

Japan.—Imports of lead into Japan broke all previous records in 1934, amounting to 94,600 metric tons, an increase of 42 percent over 1933. Of the 1934 total Canada was credited with 39,800 tons, British India 16,000 tons, and Australia 3,100 tons. The United States was credited with 35,500 tons, but probably this was largely Mexican lead, as the United States reported shipments to Japan of only 4,000 tons in 1934 compared with 19,300 tons in 1933. Since the domestic output probably amounted to about 7,000 tons in 1934 a consumption of over 100,000 tons is indicated.

Mexico.—Higher prices for gold and silver and increased demand for lead in Europe and Japan resulted in a sharp increase in production in Mexico in 1934. According to preliminary estimates smelter production was 165,416 metric tons, an increase of 40 percent over 1933 but 32 percent below the record output in 1930. Formerly large quantities of Mexican lead bullion were shipped to the United States for refining, but recently this trade has declined to very small proportions due to extension of refining capacity in Mexico. In 1928 nearly 109,000 tons of lead in Mexican base bullion were imported by the United States, but in 1934 less than 2,000 tons were brought in. Mexico now ships refined lead to Europe and Japan, the latter having taken a large tonnage in 1934.

Newfoundland.—Production of lead concentrates in 1934 totaled 46,500 short tons containing 29,300 tons of lead and 536,000 ounces of silver compared with 49,500 tons of concentrates containing 30,600 tons of lead and 627,000 ounces of silver in 1933. In addition, 162,000 tons of zinc concentrates which contained 7,600 tons of lead were produced in 1934. During the fiscal year ended June 30, 1934, 49,000 tons of lead concentrates were exported; Belgium took 37,000, Germany 7,000, and the United States 5,000.

Spain.—Lead production declined again in 1934. The total smelter output was 74,000 metric tons, which was 16 percent below 1933 and the lowest yearly output since 1868. Exports of pig lead declined from 77,700 tons in 1933 to 57,100 tons in 1934, largely due to smaller shipments to France, Netherlands, and U. S. S. R. (Russia).

Spanish lead production reached a peak of 232,000 tons in 1912. Since then, owing to exhaustion of deposits and inability to compete in the world market with newer low-cost producers, the yearly output has declined persistently. By 1928 production had fallen to only 131,000 tons. Unemployment resulting from this sharp decrease resulted in the inauguration of a program of Government aid early in 1927. As this proved ineffective, stronger measures were adopted in 1928. The industry was organized into a consortium which was given monopolistic privileges in the Spanish market. Lead was purchased from members at a price below the world price and sold in the domestic market at a price to yield a profit to the consortium. Profits so derived were used to aid the industry. Recently the activities of the consortium were subjected to considerable criticism. It was claimed that in effect economic producers were being taxed to support uneconomic producers. Early in 1935 it was reported that a bill was to be submitted to Parliament to remedy this situation. It was claimed that the present policy endangered the economic producers and the smelting industry as well.

Tunisia.—Smelter production of lead increased 84 percent in 1934 and was derived largely from imported ore. Nearly 22,000 tons of high-grade lead concentrates were shipped from Yugoslavia to Tunisia in 1934. The domestic mining industry has dwindled to negligible proportions during the period of low lead prices.

U. S. S. R. (Russia).—A large increase in lead consumption in U. S. S. R. (Russia) in 1934 is indicated by the increase in domestic production and imports. Smelter production rose from 13,700 to 27,000 metric tons, while imports increased from 16,400 to 18,700 tons; thus an increase in consumption from 30,100 tons in 1933 to 45,700 tons in 1934 is indicated. Under the second 5-year plan the Russian lead production was to have been 147,000 tons in 1934. The increase in output in 1934 was due to completion of the first section of the new Chinkent plant in January. Initial capacity was reported at 20,000 tons of lead per year. Early in 1935 it was reported that the plant at Tetiukhe had been rehabilitated and extended to treat 1,500 tons of ore a day.

Yugoslavia.—Trepca Mines, Ltd., treated 599,000 metric tons of ore in 1934, from which were obtained nearly 64,000 tons of lead concentrates containing 79 percent lead and 25 ounces of silver per ton and 93,000 tons of 50-percent zinc concentrates—an increase of 8 percent in the production of lead concentrates. Early in 1935 a new smelter at Kralyevo, Serbia, was completed, capable of producing 25 tons of lead per day. The plant is to treat ores from the Trepca mines which heretofore had been shipped to foreign smelters. In 1934 Yugoslavia exported 71,000 tons of lead ores, of which Tunisia took 22,000 tons.

ZINC [1]

By Elmer W. Pehrson

SUMMARY OUTLINE

The domestic zinc industry made little progress in 1934. Production, stimulated by the rise in price during 1933, was continued in 1934 at a rate that exceeded consumption, leading to a substantial increase in stocks and a sharp decline in price. Smelter production of primary slab zinc was 18 percent higher in 1934 than in 1933, whereas consumption increased only 6 percent. Stocks on hand at primary smelters increased from 110,487 short tons at the beginning of the year to 124,783 tons at the end. The St. Louis quotation for prime western zinc in 1934 opened at 4.35 cents per pound and closed at 3.725 cents; the average for the year was 4.16 cents, an increase of 3 percent over 1933. Production in 1934 was only 60 percent of the average from 1925 to 1929, consumption 63 percent, and price 62 percent. Figure 14 shows trends in the United States zinc industry from 1900 to 1934, inclusive.

During the first 5 months of 1934 shipments to consumers increased from less than 27,000 tons monthly to nearly 36,000 tons, but as production had averaged about 32,000 tons there was little net change in stocks for the period. In June labor troubles in Montana caused a recession in production to 25,000 tons but resulted in only a temporary decline in stocks, as consumption also dropped rapidly, deliveries amounting to less than 22,000 tons in August and September. During the last quarter shipments to consumers averaged over 30,000 tons per month, but this was accompanied by a rise in production to about 35,000 tons after the settlement of the strike in Montana the latter part of September. Stocks therefore increased steadily during the latter half of the year. Quotations were fairly well

[1] This report deals primarily with the smelting end of the industry. Some zinc ore is used directly in the manufacture of zinc pigments. (See chapter on Lead and Zinc Pigments and Zinc Salts.)

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maintained until the middle of August but declined steadily thereafter until a low of 3.675 cents was reached on November 22. Price was affected adversely in 1934 by the unsatisfactory statistical position of the metal in the domestic field, overproduction of ore in the Tri-State district, and the steady decline in the London quotation.

Outside the United States the statistical position of the metal improved considerably. Production increased 18 percent, as in the United States, but consumption increased 18 percent abroad com-

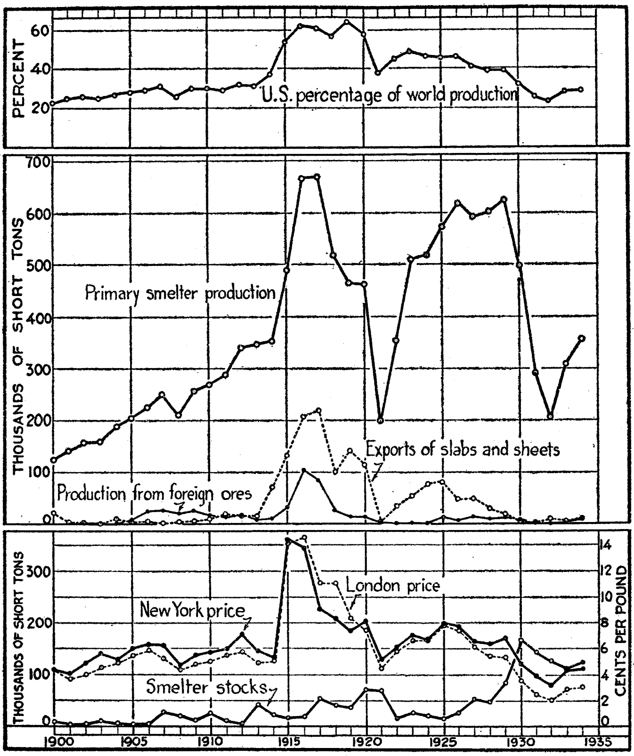

FIGURE 14.—Trends in the zinc industry in the United States, 1900–1934. Imports of slab and sheet zinc are not shown, since they seldom exceed 500 tons annually.

pared with only 6 percent at home. Stocks of zinc abroad declined appreciably, yet in spite of this improvement prices fell to extremely low levels. This was attributed to the method of administering the preferential tariff on British zinc, which permitted small offerings of foreign metal to depress the London quotation unduly, and to apprehension throughout the year for the future of the Zinc Cartel. The latter proved to be well-founded, as the cartel collapsed at the end of the year. In December 1934 the London quotation for spot zinc averaged £11.73 per long ton, which was equivalent to only £7.15 (1.55 cents per pound) under the old gold standard.

Salient statistics of the zinc industry in the United States, 1925–34

	1925-29 average	1930	1931	1932	1933	1934
Production of primary slab zinc:						
From domestic ores..........short tons..	589, 648	489, 361	291, 996	207, 148	306, 010	355, 366
From foreign ores..........do....	12, 734	8, 684	----------	----------	1, 172	8, 224
	602, 382	498, 045	291, 996	207, 148	307, 182	363, 590
Electrolytic..........percent of total..	21	26	28	11	29	21
Distilled..........do....	79	74	72	89	71	79
Production of secondary slab zinc...short tons..	65, 380	49, 300	34, 800	20, 000	48, 100	29, 300
Stocks on hand at primary smelters Dec. 31 short tons..	45, 575	167, 293	143, 592	128, 192	110, 487	124, 783
Primary zinc available for consumption....do....	544, 016	408, 469	312, 592	213, 280	321, 789	340, 529
Price—prime western at St. Louis:						
Average for year..........cents per pound..	6. 76	4. 56	3. 64	2. 88	4. 03	4. 16
Highest quotation..........do....	8. 90	5. 45	4. 12½	3. 50	5. 00	4. 40
Lowest quotation..........do....	5. 40	3. 95	3. 12½	2. 30	2. 55	3. 67½
Price—yearly average at London..........do....	6. 46	3. 60	2. 52	2. 12	2. 96	3. 07
Mine production of recoverable zinc..short tons..	724, 720	595, 425	410, 318	285, 231	384, 280	[1] 438, 501
Tri-State district (Joplin)..percent of total..	49	36	29	34	36	35
Western States..........do....	30	33	30	25	29	29
Other..........do....	21	31	41	41	35	36
World smelter production of zinc...short tons..	1, 435, 000	1, 537, 000	1, 099, 000	862, 000	1, 092, 000	1, 289, 000

[1] Subject to revision.

The domestic industry operated throughout 1934 under the President's Reemployment Agreement. The proposed code of fair competition, submitted by the industry to the National Recovery Administration on December 8, 1933, met with objections to some of its provisions covering production control, exchange of price data, wage rates, and other provisions affecting labor. Negotiations for settlement of differences were conducted during 1934, but final approval was not forthcoming until March 26, 1935. The code as finally approved provides for a code authority consisting of 6 voting members, 5 selected from the directorate of the American Zinc Institute and 1 elected by nonmembers of the institute. The industry is divided into 10 divisions as follows: Zinc-mining, prime western smelting, high-grade zinc, secondary zinc, rolled-zinc, zinc-alloy, zinc oxide, lithopone, sulphuric acid, and special intermediate zinc. The code does not provide for price fixing or production control but authorizes the code authority to submit to the National Industrial Recovery Board for approval measures establishing fair competitive trade practices and production control. It provides further for an 8-hour day with a maximum of 40 hours per week averaged over 3 months. Minimum wages for the mining division are established at 40 cents per hour for surface and 47.5 cents for underground workers in the Northwestern district, 35 and 40 cents, respectively, in the Eastern district, and 30 and 35 cents in the Mississippi Valley, Southern, and Southwestern districts.

In approving the code the National Industrial Recovery Board reserved the right to amend the averaging provision pertaining to hours of employment and, in accordance with the findings of an impartial investigation, to increase the minimum wage rates for the Mississippi Valley, Southern, and Southwestern districts of the mining division, the revised rates not to exceed 35 cents above ground and 40 cents underground.

The President's Planning Committee for Mineral Policy, in a preliminary report released January 13, 1935, recommended the adoption by the Government of a permanent policy of production control for minerals (including zinc) of which there is excess production. The committee also recommended regular issuance by a Government agency of consumption forecasts for zinc and other minerals as an aid to intelligent planning for industry.

DOMESTIC PRODUCTION

Production of primary and secondary slab zinc.—Production of primary slab zinc in 1934 from domestic and foreign ores was 18 percent higher than in 1933 and was equivalent to 60 percent of the average output for the 5-year period 1925–29. It exceeded the depression low established in 1932 by 76 percent. Of the total output in 1934, 98 percent was derived from domestic ore and 2 percent from foreign ore. Production of secondary slab zinc decreased 39 percent from 1933 and was equivalent to 45 percent of the predepression 5-year average.

The following table shows the production of primary and secondary slab zinc during the past 10 years.

Primary and secondary slab zinc produced in the United States, 1925–34

Year	Primary (short tons)			Secondary (short tons)			Total
	Domestic	Foreign [1]	Total	Redistilled	Remelted	Total	Short tons
1925	555,631	17,315	572,946	39,181	22,249	61,430	634,376
1926	611,991	6,431	618,422	40,799	23,771	64,570	682,992
1927	576,960	15,556	592,516	42,784	22,016	64,800	657,316
1928	591,525	11,056	602,581	48,666	22,034	70,700	673,281
1929	612,136	13,311	625,447	47,348	18,052	65,400	690,847
1930	489,361	8,684	498,045	[2] 34,849	14,451	49,300	547,345
1931	291,996		291,996	[2] 21,625	13,175	34,800	326,796
1932	207,148		207,148	14,718	5,282	20,000	227,148
1933	306,010	1,172	307,182	30,087	18,013	48,100	355,282
1934	355,366	8,224	363,590	19,691	9,609	29,300	392,890

[1] Since 1926 all foreign zinc smelted in the United States has been derived from Mexican ores.
[2] Includes 22 tons of secondary electrolytic zinc in 1930 and 312 tons in 1931.

The Bureau of Mines classifies slab-zinc production as primary or secondary, according to whether it was derived directly from ore or scrap. Primary zinc is classified as domestic or foreign according to the source of the ore smelted. Secondary zinc is classified as redistilled or remelted according to the method of recovery used. The term "primary zinc", as used herein, refers only to zinc produced from ores or from the immediate byproducts of primary reduction operations. Some of this zinc soon returns to the smelter in the form of galvanizers' drosses, ashes, and scrap metal to be reworked into slab zinc. There is therefore duplication in the table of production shown above, inasmuch as the same metal may be counted as production two or more times in a single year. Although much secondary zinc enters the market indistinguishable from ordinary primary zinc and becomes part of the supply of zinc available to consumers, nevertheless it is deemed advisable to maintain a segregation of primary and secondary zinc; otherwise the long-time record of production might include metal that is constantly reworked.

Distilled and electrolytic zinc.—Of the total output of primary zinc in 1934, 79 percent was distilled and 21 percent electrolytic. Production of distilled zinc increased 31 percent in 1934, while that of electrolytic zinc decreased 13 percent, the decline being due largely to labor troubles in Montana which closed the Great Falls plant from June to September. Production of redistilled secondary zinc declined 35 percent, most of the decrease being in the output at primary smelters.

The production of primary and secondary electrolytic and distilled zinc, apportioned by method of reduction and by grades, is given in the following table:

Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1929–34, in short tons

APPORTIONED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled primary	Redistilled secondary [1]		Total
			At primary smelters	At secondary smelters	
1929	156,235	469,212	11,425	35,923	672,795
1930	131,166	366,879	[2] 8,500	26,349	532,894
1931	81,898	210,098	[3] 5,343	16,282	313,621
1932	23,208	183,940	1,596	13,122	221,866
1933	88,315	218,867	14,230	15,857	337,269
1934	76,657	286,933	4,962	14,729	383,281

APPORTIONED ACCORDING TO GRADE

Year	Grade A (high-grade)	Grade B (intermediate)	Grade C (brass special)	Grade D (selected)	Grade E (prime western)	Total
1929	207,321	27,430	96,163		341,881	672,795
1930	156,494	26,079	93,270		257,051	532,894
1931	83,445	23,924	73,274		132,978	313,621
1932	44,195	13,295	66,844		97,532	221,866
1933	104,842	27,101	57,318		148,008	337,269
1934	116,720	32,621	43,657		190,283	383,281

[1] For total production of secondary zinc see below.
[2] Includes 22 tons of secondary electrolytic zinc.
[3] Includes 312 tons of secondary electrolytic zinc.

Production of primary slab zinc by States.—Pennsylvania, with an increase of 61 percent over 1933, ranked first in production in 1934, replacing Montana, which was second; Oklahoma ranked third. All States except Montana and Illinois increased their outputs in 1934. Kansas, which had had a continuous record of production from 1877 to 1931, did not produce in 1932, 1933, and 1934.

Primary slab zinc produced in the United States, by States, 1929–34, in short tons

Year	Arkansas	Idaho	Illinois	Kansas	Montana	Oklahoma	Pennsylvania	Other States	Total	Total value
1929	17,923	16,582	112,425	37,795	138,019	111,683	108,167	82,853	625,447	$82,559,000
1930	13,917	9,509	103,331	13,682	112,908	79,742	101,916	63,040	498,045	47,812,000
1931	3,362	8,466	76,290	4,660	63,090	26,924	65,445	43,759	291,996	22,192,000
1932	639	5,955	67,610		17,250	27,226	55,536	32,932	207,148	12,429,000
1933	9,129	7,686	60,140		80,629	52,000	62,583	35,015	307,182	25,803,000
1934	11,808	9,935	55,773		66,722	61,711	100,728	56,913	363,590	31,269,000

Secondary zinc.—Besides the redistilled and remelted secondary slab zinc (unalloyed) mentioned previously a large quantity of secondary zinc is recovered each year in the form of alloys, zinc dust, zinc pigments, and zinc salts. The total quantity recovered in 1934, including unalloyed zinc, was 95,000 tons, a decrease of 21 percent from 1933. The 1934 total was equivalent to 26 percent of the total primary zinc production compared with 39 percent in 1933 and 28 percent during the 5 years from 1925 to 1929. The decline in 1934 was due to depletion of available stocks of scrap for redistillation and remelting which resulted from the large increase in production in 1933. Further details are given in the chapter on Secondary Metals.

Byproduct sulphuric acid.—An important byproduct of zinc smelting is sulphuric acid made from the sulphur dioxide gases evolved from the roasting of zinc blende. Some of these plants also use large quantities of sulphur in addition to blende to utilize a larger proportion of their acid-producing capacity. The following table shows the production of sulphuric acid at zinc-blende roasting plants during the past 6 years.

Production and value [1] of sulphuric acid (60° B. basis) made at zinc-blende roasting plants in the United States, 1929–34

Year	Made from zinc blende		Made from sulphur		Total		
	Short tons	Value	Short tons	Value	Short tons	Value	Value per ton
1929	627,018	$6,038,183	646,980	$6,230,417	1,273,998	$12,268,600	$9.63
1930	536,614	5,167,593	474,092	4,565,506	1,010,706	9,733,099	9.63
1931	426,618	3,745,706	[2] 381,216	3,347,077	807,834	7,092,783	8.78
1932	341,340	2,594,184	244,644	1,859,294	585,984	4,453,478	7.60
1933	355,027	2,676,904	242,493	1,828,397	597,520	4,505,301	7.54
1934	[3] 406,984	3,215,173	89,162	704,380	496,146	3,919,553	7.90

[1] At average of sales of 60° acid.
[2] Includes acid made from small quantity of pyrites.
[3] Includes acid from small quantity of foreign blende.

Production of byproduct acid from zinc blende increased 15 percent in 1934. The large decline in acid made from sulphur at byproduct plants was due mainly to the fact that the product of four plants previously listed as byproduct is not included in the 1934 totals. These plants were reported as having abandoned permanently the production of byproduct acid. The use of sulphur at byproduct plants included in the 1934 totals, however, decreased more than 20 percent from 1933.

Details of production of byproduct sulphuric acid at zinc-blende roasting plants in the United States, 1931–34

	1931	1932	1933	1934
Number of establishments	21	20	18	14
Blende used ... short tons	439, 243	340, 961	366, 979	[1] 421, 955
Sulphur used ... do	[2] 100, 956	65, 510	64, 984	23, 424
Acid reported as 50°–60° B.:				
Produced (expressed as 60° B.) ... do	390, 278	290, 237	346, 084	[3] 359, 340
Consumed at works (expressed as 60° B.) ... do	16, 375	13, 061	19, 742	27, 461
Sold (expressed as 60° B.) ... do	373, 254	274, 581	341, 670	[3] 343, 786
Value of acid sold:				
Total	$3, 278, 509	$2, 085, 791	$2, 576, 018	$2, 714, 857
Average	$8. 78	$7. 60	$7. 54	$7. 90
Acid reported as 66° B. and stronger:				
Produced (expressed as 66° B.) ... short tons	347, 964	246, 456	209, 530	114, 005
Consumed at works (expressed as 66° B.) ... do	46, 473	36, 698	24, 620	----------
Sold (expressed as 66° B.) ... do	294, 034	211, 370	188, 533	115, 633
Value of acid sold:				
Total	$3, 884, 404	$2, 525, 583	$2, 169, 398	$1, 424, 467
Average	$13. 21	$11. 95	$11. 51	$12. 32
Total acid sold, equivalent in 60° B.:				
Quantity ... short tons	726, 094	528, 225	567, 910	[3] 482, 546
Value	$7, 162, 913	$4, 611, 374	$4, 745, 416	$4, 139, 324
Total acid consumed at works (60° B.) ... short tons	72, 142	57, 099	49, 286	27, 461

[1] Includes small quantity of foreign blende.
[2] Includes small quantity of pyrites.
[3] Includes acid from small quantity of foreign blende.

Rolled zinc.—Production of rolled zinc declined slightly in 1934 but was equivalent to about 70 percent of the 1929 output, whereas the output of primary zinc in 1934 was only 58 percent of the 1929 total. As prices of rolled zinc have declined less than those of slab zinc the value added by rolling increased from 2.4 cents per pound in 1929 to 3.3 cents in 1934. Some producers fabricate their rolled zinc into forms other than those shown in the accompanying table. In 1934, 9,333 tons of scrap resulting from these operations were remelted and rerolled. Zinc lost in waste products such as skimmings and drosses and pot losses totaled 1,200 tons in 1934—equivalent to about 3 percent of the net production of rolled zinc. Of the zinc purchased for rolling in 1934, 47 percent was brass special, 18 percent high-grade spelter, 18 percent selected and intermediate, 13 percent prime western, and 4 percent electrolytic. Stocks of slab zinc on hand at zinc-rolling mills were about 6,300 tons both at the beginning and end of the year.

Production of rolled zinc and quantity available for consumption in the United States, 1933–34

	1933			1934		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Sheet zinc not over 0.1 inch thick	12,810	$2,115,000	$0.083	13,082	$2,338,000	$0.089
Boiler plate and sheets over 0.1 inch thick	469	72,000	.077	817	118,000	.072
Strip and ribbon zinc [1]	27,982	3,868,000	.069	27,017	3,745,000	.069
Total zinc rolled	41,261	6,055,000	.073	40,916	6,201,000	.076
Imports	46	6,700		55	7,000	
Exports	3,189	468,000	.073	3,462	569,000	.082
Available for consumption	38,118			37,509		
Slab zinc (all grades)			.042			.043
Value added by rolling			.031			.033

[1] Figures represent net production. In addition 6,342 tons in 1933 and 9,333 tons in 1934 were rerolled from scrap originating in fabricating plants operated in connection with zinc-rolling mills.

Zinc dust.—Commercial production of zinc dust in the United States began in 1910 and reached a maximum of about 11,500 tons in 1920. From 1922 to 1927 the annual production averaged about 8,000 tons. In 1934, 10,856 tons were produced—3 percent less than in 1933.

The zinc content of zinc dust produced in 1934 averaged 97 percent. Since 1931 virtually all zinc dust has been produced by redistillation of zinc drosses and slab zinc. The production of atomized zinc dust for market is relatively small, and in recent years production of zinc dust directly from ore has been reported.

Zinc dust [1] sold by producers in the United States, 1929–34

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per pound			Total	Average per pound
1929	11,050	$1,864,672	$0.084	1932	9,440	$900,796	$0.048
1930	9,237	1,205,740	.065	1933	11,157	1,308,594	.059
1931	10,611	1,148,152	.054	1934	10,856	1,342,133	.062

[1] The zinc dust produced is principally "distilled." Some "atomized" dust was produced in each of the years shown except 1934, but the Bureau of Mines is not at liberty to publish the figures separately.

Zinc pigments and salts.—Zinc oxide, leaded zinc oxide, and lithopone are the principal pigments of zinc and the chloride and sulphate the principal salts. These products are manufactured from various zinciferous materials—ores, metal, and secondary substances. Details of the production of zinc pigments and salts are given in the chapter on Lead and Zinc Pigments and Zinc Salts. In 1934 the total zinc content of all zinc pigments and salts produced in the United States was 120,635 tons, 5 percent less than in 1933. Of the 1934 total, 63 percent was derived from ores, 21 percent from slab zinc, and 16 percent from secondary materials.

Mine production.—The following table shows the mine production of recoverable zinc in the United States, by States, from 1925 to 1934.

Mine production of recoverable zinc in the United States, 1925–34, in short tons

State	1925–29 average	1930	1931	1932	1933	1934
Western States:						
Arizona	2,628	815			6	[1] 890
California	3,999		80		145	361
Colorado	32,868	36,259	16,187	109	1,285	772
Idaho	29,128	37,649	19,569	10,252	20,968	[1] 25,000
Montana	72,519	26,421	6,747	2,197	20,724	[1] 30,500
Nevada	5,570	14,584	10,431	127	6,387	[1] 13,750
New Mexico	23,351	32,765	27,866	25,593	30,924	26,522
Oregon		6		6	6	37
Utah	44,385	44,495	37,291	29,666	29,745	28,198
Washington	575	352	4,974	2,245	3,369	1,926
	215,023	193,346	123,145	70,195	113,559	[1] 127,956
Central States:						
Arkansas	71				11	68
Illinois	1,174	9				
Kansas	114,323	74,304	39,051	26,277	40,947	38,261
Kentucky	644			46	228	125
Missouri	16,708	10,811	3,205	986	5,042	7,059
Oklahoma	226,969	136,153	78,132	63,437	91,065	107,772
Wisconsin	23,055	12,558	10,088	7,522	7,800	9,807
	382,944	233,835	130,476	98,268	145,093	163,092
Eastern States:						
New Jersey	93,839	97,626	94,285	81,460	75,125	76,553
New York	7,091	22,471	24,100	16,794	17,733	23,188
Tennessee and Virginia [2]	25,823	48,147	38,312	18,514	32,770	47,712
	126,753	168,244	156,697	116,768	125,628	147,453
	724,720	595,425	410,318	285,231	384,280	[1] 438,501

[1] Subject to revision.
[2] Bureau of Mines not at liberty to publish figures for Tennessee and Virginia separately.

Mine production of zinc increased 14 percent in 1934 but was still 39 percent below the yearly average from 1925 to 1929. All sections of the country shared in the 1934 advance, production having increased 17 percent in the Eastern States, 13 percent in Western States, and 12 percent in Central States. Compared with predepression levels, however, the output of the Eastern States in 1934 was 16 percent greater, whereas that of the Central and Western States was 57 and 40 percent less, respectively.

Oklahoma again ranked first in production in 1934 with an increase of 18 percent over 1933. New Jersey ranked second, with only a 2-percent increase. Tennessee-Virginia ranked third with an increase of 46 percent. Kansas, which ranked fourth, recorded a decrease of 7 percent in output. Other important producing States that showed decreases were Utah, 5 percent, and New Mexico, 14 percent. Other States showed increases as follows: Montana 47 percent, Idaho 19 percent, New York 31 percent, Nevada 115 percent, Wisconsin 26 percent, and Missouri 40 percent. The 1934 production of Tennessee-Virginia, New Mexico, New York, Nevada, and Washington exceeded the 5-year average from 1925 to 1929.

The table that follows shows the output of the principal zinc-producing districts of the United States during the past 6 years.

Further details of operations in these districts are given in the State reports included in this volume.

Mine production of recoverable zinc in the principal zinc-producing districts of the United States, 1929–34, in short tons

District	State	1929	1930	1931	1932	1933	1934
Joplin region	Kansas, Missouri, Oklahoma.	309,436	216,961	119,168	90,660	137,054	153,092
New Jersey	New Jersey	103,740	97,626	94,285	81,460	75,125	76,553
Eastern Tennessee	Tennessee	40,558	48,147	38,312	18,514	32,770	47,712
Austinville	Virginia						
Coeur d'Alene region	Idaho	43,046	33,145	18,934	10,251	20,958	[1] 25,000
St. Lawrence County	New York	10,250	22,471	24,100	16,794	17,733	23,188
Summit Valley (Butte).	Montana	50,550	13,984			15,481	[1] 21,168
Willow Creek	New Mexico	22,865	16,638	20,817	20,356	18,665	16,847
Bingham	Utah	21,794	22,362	26,608	21,746	20,648	16,611
Upper Mississippi Valley.	Iowa, northern Illinois, Wisconsin.	17,017	12,567	10,088	7,522	7,800	9,807
Park City region	Utah	27,965	19,543	9,436	7,863	8,296	9,693
Central	New Mexico	11,224	15,319	7,050	5,121	11,220	9,109
Pioche	Nevada	6,498	11,086	6,708	(2)	(2)	(3)
Metaline Falls	Washington	1,031	352	4,974	2,245	3,369	1,926
Leadville	Colorado	13,414	11,519	2,887	63	1,246	515
San Juan Mountains	do	14,403	10,434	41	4	9	125
Battle Mountain	do	420	14,272	13,259			
Southeastern Missouri region.	Missouri	3,473	4,307	1,220	40		

[1] Subject to revision.
[2] Bureau of Mines not at liberty to publish figures.
[3] Data not available.

STOCKS

Stocks of zinc at primary reduction plants increased 13 percent in 1934, ending the steady record of declines since the recent high at the end of 1930. At the close of the year they were 25 percent below the 1930 level but about 2.7 times as large as the average from 1925 to 1929. Stocks at secondary distilling plants also increased slightly. An analysis of the increase in 1934 shows that stocks of the higher grades of zinc (A and B) decreased 18 percent while those of the lower grades (C, D, and E) increased 20 percent. At the beginning of 1934 there were on hand 21,688 tons of grades A and B and 91,278 tons of grades C, D, and E. At the close of the year the tonnages were 17,796 and 109,672, respectively.

Stocks of zinc on hand at zinc-reduction plants in the United States at end of year, 1929–34, in short tons

	1929	1930	1931	1932	1933	1934
At primary reduction plants	85,904	167,293	143,592	128,192	110,487	124,783
At secondary distilling plants	3,549	1,909	2,497	3,370	2,479	2,685
	89,453	169,202	146,089	131,562	112,966	127,468

The increase in stocks of smelted zinc was accompanied by an increase in stocks of zinc ore in the Joplin district. At the beginning of 1934 about 7,000 tons of concentrates were on hand, with an estimated recoverable zinc content of 3,700 tons. By the end of the year stocks amounted to 15,000 tons of ore, representing about 8,000 tons of metal. This, however, was a substantial reduction from the 24,000 tons of ore on hand at the end of June 1934.

Stocks of slab zinc outside of the United States were reported at 122,000 tons at the close of the year by the International Zinc Cartel. Since 148,000 tons were on hand at the close of 1933 there was a reduction of 26,000 tons in zinc stocks abroad. World stocks of slab zinc may therefore be estimated roughly at 261,000 tons on January 1 and 249,000 tons on December 31, 1934, a decrease of 5 percent. World stocks at the close of 1934 were equivalent to about 2½ months' supply at the average rate of consumption in 1934.

DOMESTIC CONSUMPTION

New supply.—The supply of new zinc available for consumption in 1934 increased 6 percent over 1933 but still was 41 percent below the record year 1928. Withdrawals of new copper on domestic account declined 5 percent from 1933, and the supply of new lead available for consumption increased about 22 percent. Shipments of pig iron increased about 9 percent in 1934. Consumption of new zinc in 1934 was 63 percent of the predepression 5-year average, while that of lead and copper was 44 and 41 percent, respectively. The better showing of primary zinc may be ascribed to the fact that a smaller proportion of zinc than of copper and lead is consumed in the manufacture of capital goods, production of which has lagged behind consumers' goods. A very large proportion of zinc is used in galvanized wares, paint pigments, radio and flashlight batteries, fruit-jar covers, and other items which pass on to the consuming public rapidly. Moreover, the uses to which zinc is put are such that there is much less return of scrap than in the case of lead and copper.

The following table gives the quantity of new zinc available for consumption in the United States during the past 6 years.

Primary slab zinc available for consumption in the United States, 1929–34, in short tons

	1929	1930	1931	1932	1933	1934
Supply:						
Stock Jan. 1:						
At smelters	[1] 48,432	85,904	167,293	143,592	128,192	110,487
Production	625,447	498,045	291,996	207,148	307,182	363,590
Imports, foreign [2]	226	346	294	349	1,936	1,780
Imports, domestic, returned			3			
Total available	674,105	584,295	459,586	351,089	437,310	475,857
Withdrawn:						
Exports, foreign, from warehouse	(3)	(3)	(3)	(3)	(3)	(3)
Exports, foreign, under drawback		32		136	700	1,978
Exports, domestic	[3] 19,676	[3] 8,501	[3] 3,402	[3] 9,481	[3] 4,334	[3] 8,567
Stock Dec. 31:						
At smelters	85,904	167,293	143,592	128,192	110,487	124,783
Total withdrawn	105,580	175,826	146,994	137,809	115,521	135,328
Available for consumption	568,525	408,469	312,592	213,280	321,789	340,529

[1] Includes stocks at secondary distilling plants.
[2] Includes sheets.
[3] Foreign exports included under domestic exports. Figures include plates and sheets.

The foregoing table attempts to include only primary slab zinc or zinc produced from ores. Each year primary smelters produce a substantial tonnage of redistilled secondary zinc, most of which is inseparable from primary metal; therefore, smelter stocks at the end of the year and exports of domestic zinc probably contain some secondary metal, although the amount is relatively small. More precise segregation of figures for primary and secondary metal is virtually impossible. As the table does not consider the fluctuation in consumers' stocks, only the general trend of consumption of primary zinc is indicated.

Industrial use of slab zinc.—In addition to the new supply noted above, a large tonnage of secondary zinc is available each year for industrial use. The American Bureau of Metal Statistics estimates the total industrial use of primary and secondary zinc during the past 6 years as follows:

Estimated industrial use of zinc in the United States, 1929–34, in short tons [1]

Purpose	1929	1930	1931	1932	1933	1934
Galvanizing:						
Sheets	142,800	103,900	77,100	52,500	74,400	83,300
Tubes	52,200	38,800	28,300	16,000	22,600	22,000
Wire	39,000	25,100	21,600	12,100	21,700	20,000
Wire cloth	10,800	9,400	6,900	4,400	4,800	4,000
Shapes [2]	45,200	39,800	34,100	24,000	24,500	22,700
	290,000	217,000	168,000	109,000	148,000	152,000
Brass and castings [3]	185,000	120,000	98,000	66,000	94,000	98,000
Rolled zinc	[4] 68,300	[4] 51,400	49,300	40,000	41,300	40,900
Die castings	36,000	21,500	20,000	17,000	26,000	32,000
Other purposes [5]	55,000	41,000	34,700	27,000	41,000	37,000
	634,300	450,900	370,000	259,000	350,300	359,900

[1] Year Book, American Bureau of Metal Statistics, 1934.
[2] Includes pole-line hardware, hollow ware, chains, and all articles not elsewhere mentioned. The estimates for the use of slab zinc under this head, and also for wire cloth, are probably incomplete.
[3] Includes all casting other than die casting, slush casting, and battery zinc.
[4] Includes some duplication of tonnage. (See p. 106.)
[5] Includes slab zinc used for manufacture of French oxide, lithopone, atomized zinc dust, wire, zinc for wet batteries, slush castings, and for the desilverization of lead.

Industrial use of zinc increased only 3 percent in 1934 and was equivalent to 57 percent of the quantity used in 1929. Galvanizing consumed 42 percent of the 1934 total. The increase in this field was relatively small, a substantial rise in the production of galvanized sheets having been offset by decreased production of tubes, wire, and other shapes. Less than 2,000 tons of zinc were used in electrogalvanizing compared with over 2,500 tons in 1933. Greater expenditure of funds to promote the use of higher-grade galvanized products was urged at the annual convention of the American Zinc Institute in April 1935. Increased automobile production again was reflected in the 23-percent increase in the use of zinc in die castings. The automotive industry also used more rolled zinc in 1934, but declines in some other uses of this commodity resulted in a small decrease in the total production. This outlet for slab zinc, however, has not fallen as much as other important uses of zinc during the depression, owing to the unusual demand for fruit-jar covers, which represent the largest use of rolled zinc. Brass making, which ranks second in zinc consumption, increased 4 percent in 1934. Miscellaneous uses of zinc declined 10 percent in 1934, due principally to a decrease in the amount of zinc used in the manufacture of French-process zinc oxide. In 1934 only 25,000 tons of zinc were so used compared with 33,000 tons in 1933.

PRICES

The price of zinc trended downward throughout 1934, but the average for the year was slightly above that in 1933. The St. Louis quotation for prime western averaged 4.16 cents per pound, an increase of 3 percent over 1933 and 44 percent above the record low of 1932; it was 36 percent below the 1929 average. At the beginning of the year the quotation stood at 4.35 cents. After declining to 4.25 cents in January it rose to 4.40 cents in February. During March, April, and May the price fluctuated within narrow limits, but during June it dropped to 4.20 cents. Notwithstanding a substantial decline in smelter stocks of slab zinc during this period producers were unable to realize price increases owing to overproduction of zinc ore in the Tri-State district and a steadily declining London market. In July the price rose slightly to 4.35 cents, but thereafter it fell off sharply, reaching a low of 3.67½ cents during the latter part of November. This decline was due to a sharp increase in production and a decrease in consumption which resulted in large increases in smelter stocks during the latter half of the year. By the close of the year the quotation had risen to 3.72½ cents.

Prices of zinc and zinc concentrates, 1929–34

	1929	1930	1931	1932	1933	1934
Average price of common zinc at—						
St. Louis (spot)............cents per pound..	6.49	4.56	3.64	2.88	4.03	4.16
New York............do....	6.84	4.91	3.99	3.25	4.40	4.51
London............do....	5.40	3.60	2.52	2.12	2.96	3.07
Excess New York over London............do....	1.44	1.31	1.47	1.13	1.44	1.44
Joplin 60-percent zinc concentrates:						
Price per short ton............dollars..	42.39	31.97	22.69	17.83	26.88	27.14
Price of zinc content............cents per pound..	3.53	2.66	1.89	1.49	2.24	2.26
Smelter's margin............do....	2.96	1.90	1.75	1.39	1.79	1.90
Price indexes (1925–29 average=100):						
Zinc (New York)............	96	69	56	46	62	63
Lead (New York)............	91	74	57	43	52	52
Copper (New York)............	123	89	56	38	48	58
Nonferrous metals [1]............	107	83	63	50	60	68
All commodities [1]............	97	88	74	66	67	76

[1] Based on price indexes of the U. S. Department of Labor.

The preceding table presents a 6-year summary of zinc price data. It will be noted that in 1934 quotations averaged 4.51 cents in New York and 3.07 cents (United States exchange basis) in London, making a differential of 1.44 cents in favor of New York compared with 1.44 cents in 1933 and 1.13 cents in 1932. The differential varied within relatively narrow limits in 1934, ranging from an average of 1.29 cents in April to 1.64 cents in July.

In terms of price zinc has staged a greater recovery than lead or copper. The New York average price for zinc in 1934 was 63 percent of the predepression average, whereas prices of lead and copper were only 52 and 58 percent, respectively. These three metals, however, have not fared as well as the nonferrous metal group as a whole and are considerably below the average price level of all commodities.

The price of 60-percent zinc concentrates at Joplin averaged $27.14 per ton in 1934, an increase of 1 percent over 1933; it was still 36 percent below the 1929 average. The 1934 average was equivalent to 2.26 cents per pound of contained zinc. Since the St. Louis price of zinc averaged 4.16 cents, the difference of 1.90 cents per pound covers metallurgical losses, the cost of smelting and marketing, and such smelting profits as are realized. This was an increase of 6 percent over the smelter's margin in 1933, but was only 64 percent of the margin in 1929.

The following table shows the monthly fluctuations in quotations of common zinc at St. Louis and London and of 60-percent zinc concentrates at Joplin during 1933 and 1934. The New York quotation for slab zinc exceeds that at St. Louis by the freight differential, which normally is 0.35 cent per pound. From January 4, 1932, to September 30, 1933, the differential was increased to 0.37 cent per pound due to a temporary increase in the freight rate. On April 18, 1935, another increase in rates became effective which increased the freight differential to 0.375 cent.

Average monthly quoted prices of common zinc (prompt delivery or spot) at St. Louis and London, and of 60-percent zinc concentrates at Joplin, 1933–34 [1]

Month	1933			1934		
	60-percent zinc concentrates in the Joplin region (dollars per ton)	Metallic zinc (cents per pound)		60-percent zinc concentrates in the Joplin region (dollars per ton)	Metallic zinc (cents per pound)	
		St. Louis	London		St. Louis	London
January	18.00	3.01	2.16	25.65	4.27	3.31
February	16.57	2.67	2.12	28.65	4.39	3.33
March	16.89	3.00	2.24	30.00	4.37	3.35
April	19.67	3.31	2.39	29.30	4.37	3.43
May	25.43	3.80	2.72	29.16	4.35	3.36
June	29.72	4.35	3.14	26.70	4.24	3.21
July	33.16	4.89	3.69	28.00	4.32	3.03
August	34.96	4.91	3.39	28.00	4.28	3.09
September	31.80	4.70	3.50	25.25	4.06	2.82
October	31.00	4.74	3.40	25.00	3.84	2.69
November	30.30	4.52	3.46	25.10	3.73	2.67
December	28.89	4.47	3.39	25.56	3.71	2.59
Average for year	26.88	4.03	2.96	27.14	4.16	3.07

[1] All quotations from Metal Statistics, 1935. Conversion of English quotations into American money based on average rates of exchange recorded by the Federal Reserve Board of the Treasury.

The following table shows the actual prices received by producers for various grades of zinc during the past 6 years. It will be noted that all producers do not realize the premiums usually quoted in the trade journals for the higher grades of zinc.

Average price of zinc received by producers, 1929–34, by grades, in cents per pound

	1929	1930	1931	1932	1933	1934
Grade A (high grade) [1] Grade B (intermediate)	6.80	4.92	4.00	3.25	4.35	4.50
Grades C and B (select and brass special)[1]	6.44	4.71	3.63	2.95	3.98	4.10
Grade E (prime western)	6.42	4.69	3.73	2.85	4.07	4.15
All grades	6.6	4.8	3.8	3.0	4.2	4.3
Prime western; average spot quotation at St. Louis	6.5	4.6	3.6	2.9	4.0	4.2

[1] American Metal Market quotes average prices of high grade and brass special as follows: High grade (f. o. b. New York), 1929, 7.88 cents; 1930, 5.58 cents; 1931, 4.63 cents; 1932, 3.99 cents; 1933, 5.25 cents; 1934, 5.24 cents. Brass special (f. o. b. East St. Louis), 1929, 6.60 cents; 1930, 4.64 cents; 1931, 3.73 cents; 1932, 2.96 cents; 1933, 4.08 cents; 1934, 4.23 cents.

ZINC-REDUCTION PLANTS

Zinc smelters.—Disturbed industrial conditions and the introduction in 1929 of large, continuously operated vertical retorts have sharply curtailed activities during the past few years at plants using horizontal-type retorts. At the end of 1925, 25 active smelters were operating 95,460 retorts. On December 31, 1934, 13 active smelters were using 33,231 horizontal retorts, an increase of 25 percent over the 26,674 in use at the end of 1933 and 67 percent over the recent low at the end of 1931. Only 46 percent of the regular retorts in the plants operating at the end of 1934 were in use.

At the end of 1934, 40 continuously operated vertical retorts were installed, but data on the number in operation are not available.

The following table shows the primary zinc-smelting plants in the United States at the end of 1934.

Primary zinc-smelting plants in the United States at end of 1934

Operating company (A=acid plant situated at the smelter)	Situation of plant	Regular horizontal retorts	Large vertical retorts
Athletic Mining & Smelting Co.	Fort Smith, Ark.	3,328	
Van Buren Zinc Co.[1]	Van Buren, Ark.	3,200	
American Zinc Co. of Illinois (A)	East St. Louis, Ill.	5,760	
Hegeler Zinc Co. (A)	Danville, Ill.	5,400	
Illinois Zinc Co. (A)	Peru, Ill.	3,200	
Matthiessen & Hegeler Zinc Co. (A)	La Salle, Ill.	6,420	
Mineral Point Zinc Co. (A)[2]	Depue, Ill.	5,912	8
Grasselli Chemical Co.[3]	Terre Haute, Ind.	4,200	
American Steel & Wire Co.[3]	Cherryvale, Kans.	5,160	
Blackwell Zinc Co., Inc.	Blackwell, Okla.	9,600	
Eagle-Picher Mining & Smelting Co.	Henryetta, Okla.	4,800	
National Zinc Co., Inc. (A)	Bartlesville, Okla.	4,256	
Nellmar Corporation[3]	Kusa, Okla.	3,760	
Quinton Spelter Co.[3]	Quinton, Okla.	3,360	
American Steel & Wire Co. (A)	Donora, Pa.	7,904	
American Zinc & Chemical Co. (A)	Langeloth, Pa.	4,864	
New Jersey Zinc Co. (of Pennsylvania) (A)	Palmerton, Pa.	7,200	16
American Smelting & Refining Co.	Amarillo, Tex.	6,400	
Grasselli Chemical Co.[4]	Meadowbrook, W. Va.	6,720	16
United Zinc Smelting Corporation (A)	Moundsville, W. Va.	2,368	
Total retorts		103,812	40
Number of retorts in use at end of year		33,231	(5)
Percent of total		32.0	(5)

1 Idle since 1927.
2 Idle throughout 1934.
3 Idle throughout 1933 and 1934.
4 Horizontal-retort plant idle throughout 1933 and 1934.
5 Data not available.

In addition to the primary zinc smelters listed in the foregoing table the Federated Metals Corporation has a smelter at Beckemeyer, Ill., which contains 1,032 regular horizontal retorts. This plant formerly treated ores, but in recent years has been operated on secondary materials exclusively. The Sandoval Zinc Co. has a plant at Sandoval, Ill., containing 896 regular horizontal retorts which has been operated exclusively on secondary materials for several years. Both plants were operated at part capacity in 1934. Other secondary smelters which produced zinc in large graphite retorts in 1934 were the General Smelting Co., Philadelphia, Pa.; Nassau Smelting & Refining Co., Tottenville, N. Y.; Superior Zinc Corporation, Bristol, Pa.; Trenton Smelting & Refining Branch of Federated Metals Corporation, Trenton, N. J.; and Wheeling Steel Corporation, Wheeling, W.

Va. The secondary smelter of the Birmingham Smelting & Refining Co. was idle throughout the year.

Electrolytic plants.—The Evans-Wallower Zinc Co. plant at East St. Louis and the Anaconda plant of the Anaconda Copper Mining Co. were idle throughout 1934. At the close of the year the Kellogg plant of the Sullivan Mining Co. and the Great Falls plant of the Anaconda Copper Mining Co. were operating at part capacity. On December 31, 1934, electrolytic-zinc production in the United States was about one-half of rated capacity.

FOREIGN TRADE [2]

Foreign trade of the United States in zinc normally consists largely of imports of zinc ore smelted in bond and exports of slab zinc derived from the foreign ore. Considerable domestic ore was exported before the war and from 1925 to 1927. There is a fairly steady export trade in rolled zinc, zinc dust, and zinc dross, and some flow of zinc pigments into and out of the country. During recent years foreign trade has declined to small proportions.

Imports.—The following tables give zinc imports into the United States from 1929 to 1934 and a record of bonded-warehouse inventories.

Total imports of zinc ore into the United States, 1929–34, [1] *zinc content in short tons*

Year	Canada	Mexico	Other countries	Total	Year	Canada	Mexico	Other countries	Total
1929	848	13,563		14,411	1932		1,904		1,904
1930	13	25,644	182	25,839	1933	44	2,089	(2)	2,133
1931	(2)	778	2	780	1934	(2)	14,277	(2)	14,277

[1] Data for 1934 include ore imported for immediate consumption plus material entering the country under bond and are comparable to "general imports" given in the table for 1929–33.
[2] Less than 1 ton.

Zinc remaining in warehouse in the United States, Dec. 31, 1929–34

Year	Ore		Blocks, pigs, and old		Zinc sheets	
	Zinc content (pounds)	Value	Pounds	Value	Pounds	Value
1929	3,758,809	$113,479				
1930	27,185,311	784,670			43,334	$2,081
1931	22,377,439	269,019	22,909	$160	71,089	2,896
1932	10,211,618	240,338			43,339	2,071
1933	7,985,703	178,291	101,523	7,622		
1934	[1] 14,354,435	(2)	(1)	(1)	(1)	(1)

[1] "Blocks, pigs, and old" and "sheets" included with "ore"; not separately recorded.
[2] Data not available.

[2] Figures on imports and exports compiled from records of the Bureau of Foreign and Domestic Commerce.

Zinc imported for consumption in the United States, 1929–34

Year	Blocks or pigs		Sheets		Old		Zinc dust		Value of manufactures	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1929	226	$21,502	(1)	$52	(1)	$20	159	$19,543	$128,395	$169,512
1930	281	25,389	65	6,420	[2] 35	[2] 1,968	76	7,086	76,062	116,925
1931	274	14,793	20	2,283	(1)	35	1	97	13,591	30,799
1932	310	20,132	39	4,636			11	966	9,318	35,052
1933	1,890	127,416	46	6,703			31	2,244	7,400	143,763
1934	1,725	112,923	55	6,978			18	1,395	8,523	129,819

[1] Less than 1 ton.
[2] Includes 33 tons of dross and skimmings, valued at $1,829, imported June 18 to Dec. 31; not separately recorded prior to change in tariff.

The chief zinc import of the United States normally is zinc ore, largely imported under bond so that it can be smelted and the metallic zinc therefrom reexported without import duties. In 1934, 14,277 tons of zinc in ore were imported, a large increase over 1933. Virtually all of this ore came from Mexico. Since all of the ore imported in 1934 was not smelted during the year, there was a large increase in bonded-warehouse inventories. Imports of slab zinc in 1933 and 1934 have been considerably higher than in previous years owing to increased shipments from Mexico and Poland. This metal is used in manufactures and exported under the drawback provisions of the tariff act. From 1929 to 1932 an average of less than 100 tons of zinc per year were exported with benefit of drawback. In 1933, 700 tons were so exported and in 1934, 1,978 tons.

Exports.—The total value of the 1934 exports of zinc ore and domestic and foreign manufactures of zinc (not including galvanized products, alloys, and pigments) was approximately $1,265,000, an increase of 53 percent over 1933 but 93 percent below the recent high in 1925.

The following table shows the principal zinc exports of the United States during the past 6 years.

Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1929–34

Year	Zinc ore and concentrates		Pigs or slabs [1]		Plates and sheets		Zinc dross		Zinc dust	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1929	71	$2,434	14,411	$1,879,039	5,265	$1,075,000	3,490	$217,019	1,256	$250,447
1930			4,633	450,417	3,868	761,007	1,162	57,288	1,177	194,252
1931	13	373	643	51,010	2,759	461,130	382	19,218	1,400	204,277
1932			6,471	277,612	3,010	432,849	178	8,357	1,378	189,236
1933	[2] 809	[2] 43,650	1,145	79,274	3,189	467,742	(2)	(2)	1,569	234,125
1934	[2] 3,452	[2] 154,035	5,105	284,023	3,462	569,208	(2)	(2)	1,658	257,709

[1] Includes slab zinc made from foreign ore. Not separately recorded.
[2] Zinc dross included with ore and concentrates; not separately recorded.

Exports tabulated in the column headed "Zinc ore and concentrates" consist mostly of zinc dross, shipments of which increased largely in 1934. Germany took 64 percent and Japan 35 percent of the total. Exports of slab zinc increased in 1934 owing to larger shipments to the United Kingdom and India, but the total quantity was only 7 percent of the 1925 shipments. Exports of plates and sheets increased 9 percent in 1934. The following table shows the exports of slab and sheet zinc by destinations during the past 4 years.

Slab and sheet zinc exported from the United States, 1931–34, by destinations, in short tons

Destination	Slabs, blocks, or pigs				Sheets, strips, etc.			
	1931	1932	1933	1934	1931	1932	1933	1934
Countries:								
Canada	7	15	(1)	5	1,087	1,497	1,417	1,442
Chile	144	4	14	3	2	2	3	2
France	-------	-------	-------	-------	13	19	25	18
Germany	79	35	11	-------	3	-------	2	6
India (British)	112	1,457	-------	1,849	1	-------	(1)	2
Japan	-------	3,371	758	471	232	197	220	159
United Kingdom	235	1,428	-------	2,562	957	1,029	991	1,161
Others	66	161	362	215	464	266	531	672
	643	6,471	1,145	5,105	2,759	3,010	3,189	3,462
Continents:								
North America	23	16	4	38	1,197	1,587	1,562	1,617
South America	145	5	43	31	195	89	254	271
Europe	354	1,611	335	2,708	1,021	1,066	1,087	1,296
Asia	121	4,839	763	2,320	339	261	272	223
Africa	-------	-------	-------	-------	1	6	11	13
Oceania	-------	-------	-------	8	6	1	3	42

1 Less than 1 ton.

Considerable zinc is exported each year in the form of brass and in galvanized iron and steel. The American Bureau of Metal Statistics estimates that 13,000 tons of zinc were exported in galvanized products in 1934 compared with 10,200 tons in 1933. Export data on zinc pigments and chemicals are given in the chapter on Lead and Zinc Pigments and Zinc Salts.

WORLD ASPECTS OF THE ZINC INDUSTRY

International (European) Zinc Cartel.—The International Zinc Cartel came to an end at the close of 1934, after having survived a rather violent existence for 3½ years. Its disruption was due primarily to the growth of economic nationalism throughout the world. Complications arising from the imposition of the British tariff on zinc, the desire of Germany to become self-sufficient with respect to zinc, and wide-spread devaluation of currencies finally proved insurmountable obstacles to the continuation of the cartel.

At the beginning of the year the cartel was functioning under an agreement made in December 1933 by which it had been extended until the end of July 1934. Authorized production was at the rate of 50 percent of capacity, but excess production was tolerated upon payment of fines. The latter provision was used to a considerable extent, as is indicated by the production in January 1934 of 58,500 metric tons of zinc by cartel members whereas the authorized output was only 47,000 tons. World stocks of zinc outside of the United States were reported at 134,242 tons at the beginning of the year. A substantial increase in stocks in January, coupled with the statement of a large Belgian producer that production in excess of quota with payment of fines had been found profitable, created some dissension among members desiring to effect a more rigid control over output.

During the next few months sales increased materially, leading to a sharp decline in stocks, but the improved statistical position did not cause any improvement in price. Meanwhile, devaluation of Czechoslovak currency, rumors of inflation in Poland, stimulation of production in some areas by higher silver prices, threatened curtailment of imports into Germany, and the increasingly difficult position of producers in the remaining countries on the gold standard all contributed to the problem of maintaining the cartel.

Moreover there was growing sentiment on the continent that the British preferential tariff was having an adverse effect on the world price. In June the life of the cartel was extended 1 month to the end of August. At a meeting in July an attempt was made to prolong the cartel a full year, but demands of the German producers for quota increases sufficient to make Germany self-sufficient prevented agreement. A compromise was effected whereby the cartel was extended to the end of the year. Production quotas were increased from 50 to 60 percent.

By this time it had become apparent that future prolongation of the cartel was extremely doubtful. Some producers began selling in anticipation of a complete collapse, so that during the latter half of the year there was a steady decline in price. In November it was rumored that several producers had signified their intention of withdrawing from the cartel, and there was a growing opinion that the cartel had maintained too much uneconomic production which eventually must be dropped to provide a sounder foundation for the industry in future. A last attempt to effect an agreement during the latter part of December was unsuccessful, so the cartel automatically ceased at the end of the year. World stocks at the end of the year (exclusive of the United States) were 110,342 tons. In January 1935, following an announcement that the British Government was investigating the tariff on zinc, fresh efforts were made to revive the cartel, but by March it was reported that all activity in that direction had stopped.

World production.—World production of zinc (smelter basis) increased 18 percent in 1934 but was 19 percent below the record output of 1929. The increase in the United States in 1934 was 18 percent, the same as the rest of the world. The United States continued to rank first in production, contributing 28 percent of the world total, compared with 39 percent in 1929. Belgium contributed 15 percent of the 1934 total and recorded a 27-percent increase. Canada ranked third in production with 10 percent of the total, followed by Poland with 8 percent, Germany with 6 percent, Australia with 5 percent, and France, Great Britain, and Norway with 4 percent each. Canada recorded the largest percentage increase, 47 percent, followed by Germany with a 43-percent increase. France was the only major producer to record a substantial decline in 1934. There were no new producing countries in 1934.

World smelter production of zinc, 1929–34, in metric tons, by countries where smelted

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1929	1930	1931	1932	1933	1934
Australia	52,705	55,782	54,696	54,054	54,822	[1] 55,000
Belgium	197,900	176,230	134,720	96,330	137,300	174,894
Canada	78,061	110,219	107,612	78,146	83,412	122,394
Czechoslovakia	10,675	13,472	7,947	6,031	6,605	[1] 7,000
France	87,330	86,928	57,113	45,700	55,753	51,203
Germany [2]	102,000	97,300	45,300	41,979	50,867	72,888
Great Britain [3]	59,234	49,378	21,582	27,300	46,000	[1] 50,000
Indo-China	3,808	3,857	2,900	2,280	3,250	[1] 3,000
Italy	15,804	19,264	16,913	17,984	23,283	24,436
Japan	22,098	24,669	25,407	27,043	30,658	[1] 33,000
Mexico	15,099	29,431	35,619	30,349	26,799	29,147
Netherlands	25,712	23,255	19,323	15,624	18,478	19,911
Northern Rhodesia	12,316	18,194	7,038	----------	18,839	19,854
Norway	5,516	34,611	39,472	39,373	44,948	[1] 45,000
Poland	169,029	174,362	130,756	84,953	82,866	92,921
Spain	11,825	10,697	10,094	9,505	8,548	8,179
Sweden	4,718	4,126	----------	----------	----------	----------
U. S. S. R. (Russia)	[4] 3,437	[4] 4,650	11,400	14,800	16,900	26,300
United States	567,393	451,816	264,893	187,921	278,669	329,842
Yugoslavia	6,291	5,514	4,504	2,157	3,461	3,534
	1,451,000	1,394,000	997,000	782,000	991,000	1,169,000

[1] Approximate production.

[2] Exclusive of secondary material (Metallgesellschaft). The figures, published by the Stat. Reichsamt, which include secondary material, are as follows: 1929, 108,429 tons; 1930, 101,385 tons; 1931, 48,621 tons; 1932, 45,035 tons. Figures for 1933 and 1934 not yet available.

[3] Some secondary material included.

[4] Year ended Sept. 30.

World consumption.—Data on production, imports, and exports of the principal zinc-consuming countries indicate that world consumption of slab zinc (including primary and some secondary) in 1934 totaled about 1,144,700 metric tons, an increase of 13 percent over 1933. In spite of this large increase the rate of consumption in 1934 was still 14 percent below the 5-year average from 1925 to 1929. This estimate does not consider the change in stocks outside of the United States and Great Britain, and since there appears to have been a decline in these stocks the figure given probably understates actual consumption.

The increase in consumption in the United States was less pronounced than in the rest of the world. Domestic deliveries of primary zinc increased only 6 percent in 1934, whereas consumption elsewhere increased 18 percent. The quantity of zinc consumed in 1934 outside the United States was larger than the predepression 5-year average, but in the United States it amounted to only 63 percent of the 1925–29 average.

The United States again ranked first in zinc consumption, having taken about 28 percent of the total. Next in order of percentage consumed were Great Britain 15 percent, Germany 15 percent, Belgium 10 percent, France 8 percent, Japan 5 percent, and Russia 3 percent. France used 8 percent less zinc in 1934 and was the only important consumer to record a decrease. Other nations increased consumption as follows: Great Britain 37 percent, Germany 27 percent, Belgium 18 percent, and Russia 42 percent.

REVIEW BY COUNTRIES

Australia.—Production was maintained at approximately full capacity throughout the year at the electrolytic plant at Risdon, Tasmania, the only zinc-reduction works in Australia. Since this exceeded the quota allotment under the cartel agreement payment of fines was required, but the economies of full-scale operation more than offset the penalties. During the year a new unit was added to the plant which was designed to increase its capacity by 16,000 long tons. Its completion was expected in March 1935.

At Broken Hill 1,256,000 tons of crude ore were raised, an increase of about 55,000 tons over 1933. All four principal producers operated in 1934. The Sulphide Corporation, having sold its acid plant and smelter at Seaton Carew, England, and having limited ore reserves in Australia, was considering capital reorganization.

At Mount Isa remodeling of the concentrator to permit production of zinc concentrates was started. Completion of the first unit was expected in March 1935. The program calls for an ultimate production of 100,000 tons of zinc concentrates per year. A loan of £500,000 was negotiated to meet current expenses and provide capital for the new installations.

Belgium.—Production of slab zinc, which is derived almost entirely from imported ores, increased 27 percent in 1934. Imports of zinc ore were 429,000 metric tons, an increase of 28 percent over 1933. Mexico, Yugoslavia, Newfoundland, India, Sweden, and Italy were the principal sources. Exports of slab zinc totaled 81,000 tons or 51 percent more than in 1933. In addition, 57,000 tons of sheet zinc, wire, etc., were exported. Over 17,000 tons of slab and scrap zinc were imported, and 36,000 tons of ore were exported. Indicated consumption of slab zinc was 112,000 tons, over half of which was fabricated into sheet and wire for export. The proposed reciprocal trade agreement between the United States and Belgium does not contain any provisions affecting zinc products. Belgium's departure from the gold standard early in 1935 should improve the competitive position of Belgian zinc producers in the world market.

Canada.—Canada's zinc production (all electrolytic) amounted to 135,000 short tons in 1934, an increase of 47 percent over 1933. Eighty-two percent of the total was produced at Trail and 18 percent at Flin Flon. Production at Trail increased 61 percent and that at Flin Flon 7 percent. Exports of slab zinc increased 37 percent to 119,000 tons, of which Great Britain took 76 percent and Japan 13 percent. Approximately 20,000 tons oı zinc in the form of ore were exported, principally to Europe.

The Sullivan mine of the Consolidated Mining & Smelting Co. of Canada, Ltd., produced 1,745,992 tons of ore from which were obtained 221,680 tons of lead concentrates and 192,552 tons of zinc concentrates. The ore treated contained more lead and silver and less zinc and recoveries were slightly lower than in 1933. Costs of production were the lowest in the history of the company. The company reported a profit of $2,212,000, after provision for depletion and depreciation, compared with $1,056,000 in 1933.

During 1934 the Hudson Bay Mining & Smelting Co., Ltd., the only zinc producer in Manitoba, mined 1,477,341 tons of ore from which (together with 383 tons of custom ore) 99,334 ounces of gold, 1,335,319 ounces of silver, 18,743 tons of copper, and 24,714 tons of zinc were produced and sold. Operating profit (before depletion and depreciation) was $3,263,000 compared with $2,700,000 in 1933. Operations were suspended 1 month during the year due to labor troubles.

France.—Production of zinc decreased 8 percent in 1934. The smelting industry depends largely on foreign ores, of which 166,000 metric tons were imported chiefly from Mexico, Newfoundland, and Spain. Some ore is reexported after yielding its sulphur content for the manufacture of sulphuric acid. Exports of ore in 1934 amounted to 32,000 tons. Imports of slab zinc were 42,000 tons, of which Belgium and Norway supplied the major part. Consumption declined from 100,000 tons in 1933 to 93,000 tons in 1934. Agitation for further Government aid to the lead and zinc mines of France and its colonies was continued in 1934, but no official action was taken.

Germany.—The 40,000-ton electrolytic-zinc plant at Magdeburg was put into operation in October 1934 and contributed largely to the 43-percent increase in smelter output. Preliminary estimates of mine production for 1934 indicate an increase of 15 percent. Notwithstanding these increases in domestic output, Germany's zinc position with respect to her need for foreign credits was decidedly worse in 1934, as net imports of zinc increased from about 72,000 tons in 1933 to 120,000 tons in 1934. This increase was due to further increases in imports of metal and ore as a result of increased consumption and substantial declines in the exports of these products, due partly to Government restrictions on exports of raw materials. Imports of slab zinc increased from 100,000 to 107,000 tons, and those of zinc ore advanced from 79,000 to 127,000 tons. Exports of the metal declined from 17,000 to 10,000 tons and of ore from 101,000 to 81,000 tons. The decline in ore shipments was due largely to the diversion of Upper Silesian ore from Poland to the new Magdeburg plant. Consumption of slab zinc, calculated by the conventional formula, increased from 134,000 tons in 1933 to 170,000 tons in 1934, the latter being augmented by approximately 20,000 tons derived from stocks and secondary metal.

The intense desire of Germany to become self-sufficient as to supplies of metals has been frustrated in recent years by the low level of prices which prevented economic operation of many German mines. This led to an agitation for tariff protection, but as the producers and consumers were unable to agree on a program the Government decided to aid the mining interests by loans to cover the difference between cost and selling price. The program was inaugurated in 1932 and continued in 1933. In 1934 it was greatly liberalized; instead of grants being repayable from future earnings subsidies became direct grants and were increased to include a legitimate return on invested capital. The new program increased the activity in zinc mining during the latter part of 1934 and early in 1935.

Great Britain.—Smelter production of zinc increased 9 percent in 1934. As consumption increased 37 percent imports rose from 83,000 long tons in 1933 to 131,000 tons in 1934. Canada supplied 58 percent of the 1934 total, Belgium 11 percent, Australia 8 percent, and other countries 23 percent. Shipments from Canada increased 49 percent. Imports of ore, upon which the domestic smelting industry depends, declined from 132,000 to 91,000 tons, of which Australia supplied 52,000 and Canada and Newfoundland 36,000. Exports of crude zinc were less than 9,000 tons in 1934.

Imperial Smelting Corporation, Ltd., which controls all active zinc smelters in Great Britain, completed a new plant at Avonmouth during the year. The plant uses the vertical retort process and has an annual capacity of 20,000 tons of zinc.

Dissatisfaction developed over the 10-percent duty on non-British zinc. Although the statistical position of the metal was improved greatly during 1934 the London price showed a substantial decline. This was attributed to the peculiar method of administering the duty by which small offerings of foreign zinc unduly depressed the London Metal Exchange quotations. Although the tax had been successful in reserving the British market for Empire producers benefits therefrom had been nullified by the drop in price. At the close of the year the Government initiated an inquiry into the situation. There was some demand for abolition of the duty, but most producers favored a method of application that would give them the protection desired without affecting adversely the world price. Some demand for an increase in duty followed the devaluation of the belga in April 1935.

India.—The Burma Corporation, Ltd., produced 68,838 long tons of zinc concentrates, averaging about 54 percent zinc, in 1934, compared with 61,432 tons in 1933.

Italy.—Zinc production in 1934 was the highest on record, having increased 5 percent over 1933. Consumption increased 15 percent, to 27,000 metric tons, necessitating imports amounting to 3,000 tons. Italy produces an excess of zinc ore; in 1934, 36,000 tons were exported principally to Belgium. The Italian Government refused applications for increases in capacity at the electrolytic-zinc plant at Cotrone and the zinc smelters at Monteponi and Vado Ligure but authorized a subsidiary of Montecatini to erect a new electrolytic plant at Marghera near Venice. Apparently the new installation is to treat 20,000 tons of zinc concentrates annually. Mining of zinc has been sustained by Government subsidies during the last few years.

Japan.—Japan is an important consumer of zinc and is supplied by domestic production and imports. Apparent consumption increased from 57,000 tons in 1933 to 60,000 tons in 1934, the latter being met by a domestic output of 33,000 tons and imports of 27,000 tons; 13,000 tons of zinc ore were imported in 1934.

Mexico.—Mine production of zinc in 1934 amounted to 125,000 metric tons, an increase of 40 percent over 1933. In spite of this large increase, the 1934 output was still 28 percent below the record output in 1929. Smelter production amounted to 29,000 tons in 1934, leaving in excess of 96,000 tons of zinc in the form of ore available for export. In 1934 Belgium received 87,000 tons of Mexican ore, France 42,000 tons, Germany 34,000 tons, and the United States about 25,000 tons—a total of 188,000 tons.

Newfoundland.—Production of zinc concentrates increased again in 1934, amounting to 162,000 short tons containing approximately 50.5 percent zinc. In addition, 46,500 tons of lead concentrates were produced, averaging about 63 percent lead. All of the zinc concentrates and a large part of the lead concentrates were shipped to Europe.

Poland.—Although smelter production of zinc increased 12 percent in 1934 the outlook for 1935 is not so bright. The completion of the

Magdeburg plant in Germany during the latter part of 1934 deprived Poland of a large supply of ore from German Upper Silesia and a market for metallic zinc in Germany. This situation is reflected to some extent in the trade statistics for 1933 and 1934, which show a decrease in German exports of ore to Poland from 79,000 metric tons to 63,000 tons. The magnitude of the change, however, is shown more accurately by a comparison of December 1934 with December 1933. In these two periods German exports of ore to Poland declined from 5,600 to 1,100 tons, and imports of Polish zinc fell from 4,100 to 1,800 tons. This situation led to the closing down of one Polish smelter early in 1935. At the close of the year it was reported that an agreement had been made with Japan whereby Japan was to take Polish zinc in exchange for silk and other manufactured products. Giesche Spolka Akcyjna, Polish subsidiary of the Anaconda Copper Mining Co., produced about 41,000 tons of zinc in 1934, compared with 36,000 tons in 1933.

Spain.—Further decline in zinc mining is indicated by the decrease in exports of zinc ore from 75,000 metric tons in 1933 to 56,000 tons in 1934. A large part of the ore is produced at the Reocin mine in the Province of Santander. This ore is exported mainly to Norway, where it is reduced to metal by the electrolytic process. Some ores, derived as byproducts of lead mining in the southern provinces, are smelted in the south of Spain. Smelter production amounted to about 8,000 tons in 1934.

U. S. S. R. (Russia).—Production of zinc in 1934 was about 26,000 metric tons, including about 5,000 tons of eletrolytic zinc. Under the second 5-year plan production was to have been 97,000 tons in 1934. More than 4,000 tons of zinc were imported in 1934, indicating a consumption exceeding 30,000 tons. Zinc smelters are located at Constantinovo and Byelovo, each with an annual capacity of 12,000 tons. Another at Ordjonikidze has a capacity of 6,000 tons. In addition to the smelter there is an electrolytic-zinc plant at Ordjonikidze whose capacity was being doubled in 1934. The electrolytic plant at Cheliabinsk is expected to be put into operation during 1935. Inability of the reduction plants to attain capacity production was attributed to unsatisfactory exploitation of the zinc mines. At the close of 1934 zinc reserves were estimated at 7,400,000 tons.

Yugoslavia.—Trepca Mines, Ltd., treated 599,000 metric tons of ore from which were obtained 93,000 tons of 50-percent zinc concentrates and 64,000 tons of 79-percent lead concentrates. This was an increase of 10 percent in production of zinc concentrates. Costs were higher owing to the depreciation of the British pound. Only a small part of the ore is treated in Yugoslavia, the major part being shipped to Belgium for smelting. Smelter production was only 3,500 tons.

LEAD AND ZINC PIGMENTS AND ZINC SALTS

By Elmer W. Pehrson and H. M. Meyer

SUMMARY OUTLINE

Sales of lead and zinc pigments in 1934 totaled $48,000,000, an increase of 7 percent over 1933, but most of this increase was due to improved prices, as the combined tonnage of lead and zinc pigments increased less than 2 percent. In view of the 27-percent increase in dollar volume of paint sales, the 30-percent increase in rubber-tire manufacture, the 43-percent rise in automobile production, and the 17-percent rise in storage-battery output—all major pigment-consuming industries—it is apparent that lead and zinc pigments manufacturers did not receive a proportionate share of the increase in business.

Lead pigments fared better than zinc pigments in 1934. Combined sales of all lead pigments increased 15 percent in value and 10 percent in quantity, whereas sales of zinc pigments were about the same in value and decreased 3 percent in quantity. Sales of all lead pigments except sublimed lead increased in 1934. Sales of lithopone, the principal zinc pigment, also increased, but sales of zinc oxide and leaded zinc oxide were substantially lower. Unit values of all zinc pigments and all lead pigments except blue sublimed lead increased in 1934.

Increased competition was felt in 1934 from titanium pigments, production of which has risen steadily during the depression. It is estimated[1] that 32,000 tons of titanium dioxide were produced in 1934. Since a large part of the dioxide is mixed with inert fillers the total tonnage of titanium pigments marketed probably was considerably higher. These pigments are finding extensive use in paints, displacing the white lead and zinc pigments, although the latter seem to have been affected most seriously in 1934. Titanium also is being substituted for zinc oxide and lithopone in the manufacture of white rubber goods, paper, and other commodities where extreme whiteness and opacity are desired. Additional production capacity now under

[1] Chemical and Metallurgical Engineering, Progress in Pigment Industry Continues: Vol. 42, no. 1, January 1935, p. 49.

construction indicates that titanium is destined to supply even more of the pigment demand.

Other factors have curtailed consumption of zinc oxide in the rubber industry and the use of litharge in storage batteries. In the compounding of rubber the recent introduction of new accelerators has

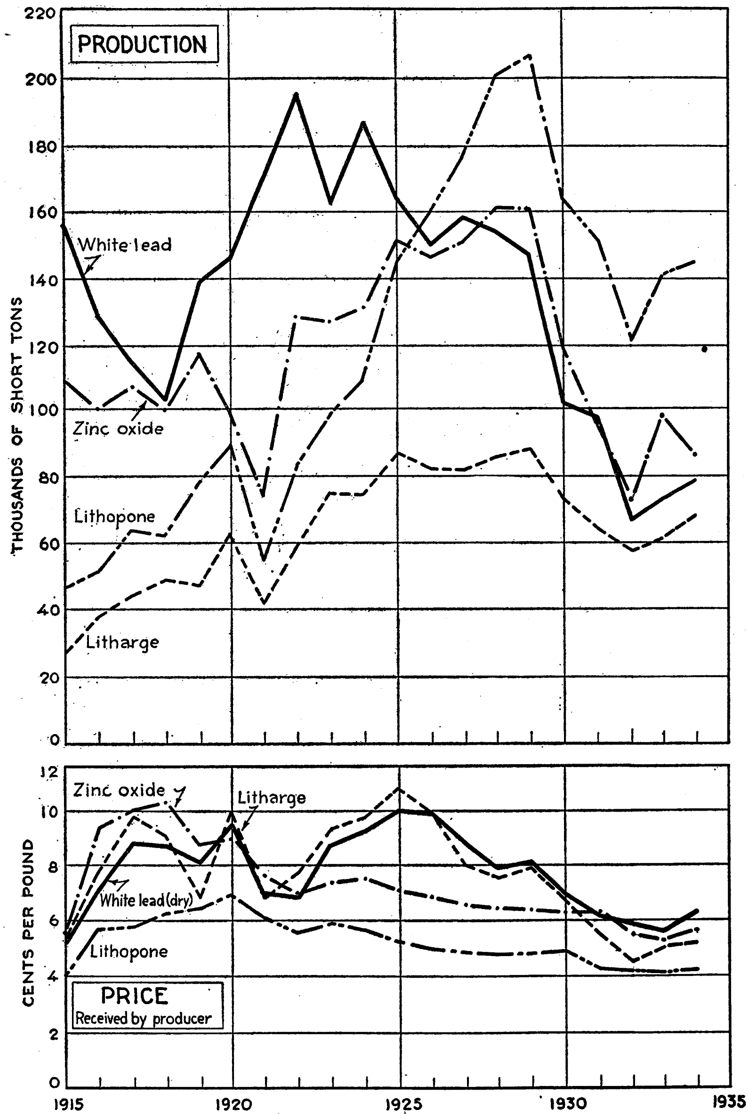

FIGURE 15.—Production and price trends of the principal lead and zinc pigments, 1915–34.

reduced the quantity of zinc oxide used per ton of rubber products. Battery manufacturers now are manufacturing in increasing quantities a black or suboxide of lead which they use in place of litharge in battery plates. For this reason sales of litharge in recent years have not kept up with the increased production of storage batteries.

Salient statistics of the lead and zinc pigments industry of the United States, 1925–34

	1925–29 (average)	1930	1931	1932	1933	1934
Production (sales) of principal pigments:						
White lead (dry and in oil) short tons	154,483	102,140	97,368	66,674	72,982	78,734
Litharge do	84,845	72,578	63,890	58,096	61,193	68,733
Red lead do	41,362	32,941	25,853	18,880	21,988	26,743
Zinc oxide do	154,208	119,142	95,700	72,250	98,542	87,088
Leaded zinc oxide do	26,609	17,279	18,577	14,305	22,868	20,506
Lithopone do	177,745	164,065	151,850	121,667	140,831	145,565
Value of products:						
All lead pigments	$60,092,000	$36,386,000	$29,128,000	$19,133,000	$20,819,000	$24,002,000
All zinc pigments	41,314,000	32,867,000	27,139,000	19,430,000	24,143,000	24,106,000
Total	101,406,000	69,253,000	56,267,000	38,563,000	44,962,000	48,108,000
Value per ton received by producers:						
White lead (dry)	178	140	124	117	112	126
Litharge	176	134	109	89	101	103
Red lead	193	154	129	111	120	123
Zinc oxide	133	125	125	110	105	113
Leaded zinc oxide	124	120	115	91	88	98
Lithopone	98	97	86	84	83	84
Foreign trade:						
Lead pigments:						
Value of exports	1,346,000	1,514,000	947,000	365,000	327,000	404,000
Value of imports	30,000	17,000	14,000	6,000	2,000	4,000
Zinc pigments:						
Value of exports	2,150,000	1,827,000	1,058,000	466,000	230,000	395,000
Value of imports	931,000	785,000	635,000	521,000	567,000	373,000
Export balance	2,535,000	2,539,000	1,356,000	304,000	[1] 12,000	422,000

[1] Import balance.

The industry and N. R. A.—The manufacture of lead pigments in 1934 was governed by the Code of Fair Competition for the Lead Industry which went into effect on June 4, 1934. The open-price features of the code were not put into effect. Zinc pigments were provided for in the zinc oxide and lithopone divisions of the code, established for the zinc industry on April 8, 1935.

PRODUCTION

In this report sales of pigments and salts are considered to represent production, no account being taken of the stocks on hand at the beginning and end of the year. The quantities used by producers at their own plants are included under sales.

The total value of lead and zinc pigments sold by domestic producers was approximately $48,108,000 in 1934, compared with $44,962,000 in 1933. The total value of all lead pigments sold was $24,002,000 and that of all zinc pigments sold, $24,106,000. Sales of lead pigments increased 15 percent in total value and 10 percent in quantity, whereas sales of zinc pigments were about the same in total value and decreased 3 percent in quantity. The average value per ton of lead pigments sold in 1934, as reported by producers, increased 4.4 percent, whereas the average New York quotation for pig lead declined 0.3 percent. Zinc pigments increased 3.4 percent in value per ton, compared with a 3.2-percent increase in the St. Louis quotation for slab zinc.

Lead pigments.—Production of white lead, litharge, red lead, and orange mineral increased in 1934, whereas that of sublimed lead decreased. Production of white lead increased 8 percent but was 60 percent below the peak of 1922. Likewise production of litharge was 12 percent higher in 1934 but was still 22 percent under the record output of 1929, and output of red lead, which increased 22 percent in 1934, was 38 percent below 1929. Production of sublimed lead was 11 percent less than in 1933. Unit values of all lead pigments except blue sublimed lead increased in 1934.

Lead pigments sold by domestic manufacturers in the United States, 1933–34

Pigment	1933			1934		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Basic lead sulphate or sublimed lead:						
White	7,320	$736,404	$101	6,399	$677,897	$106
Blue	625	65,525	105	668	69,043	103
Red lead	21,988	2,637,640	120	26,743	3,279,013	123
Orange mineral	231	45,928	199	234	50,778	217
Litharge	61,193	6,197,124	101	68,733	7,083,569	103
White lead:						
Dry	24,628	2,763,630	112	22,569	2,838,709	126
In oil [1]	48,354	8,372,689	173	56,165	10,002,820	178

[1] Weight of white lead only but value of paste.

Lead pigments sold by domestic manufacturers in the United States, 1925–34, in short tons

Year	White lead		Basic lead sulphate or sublimed lead		Red lead	Orange mineral	Litharge
	Dry	In oil	White	Blue			
1925	43,426	120,479	14,996	1,090	41,669	840	86,546
1926	37,968	111,845	12,271	1,236	42,550	813	82,540
1927	38,669	119,026	13,482	1,061	39,073	709	81,655
1928	42,049	111,923	16,002	1,234	40,497	459	85,570
1929	42,159	104,872	15,580	1,234	43,021	678	87,916
1930	32,548	69,592	10,308	1,219	32,941	356	72,578
1931	30,922	66,446	8,790	896	25,853	282	63,890
1932	19,946	46,728	5,708	549	18,880	212	58,096
1933	24,628	48,354	7,320	625	21,988	231	61,193
1934	22,569	56,165	6,399	668	26,743	234	68,733

Zinc pigments and salts.—Production of zinc oxide and leaded zinc oxide declined 12 and 10 percent, respectively, in 1934, whereas that of lithopone increased 3 percent. The 1934 tonnages were equivalent to the following percentages of the 1929 outputs: Zinc oxide 54, leaded zinc oxide 76, and lithopone 71. Unit values of all three pigments increased in 1934.

Zinc pigments and salts sold by domestic manufacturers in the United States, 1933–34

Pigment or salt	1933			1934		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Zinc oxide [1]	98,542	$10,379,937	$105	87,088	$9,851,421	$113
Leaded zinc oxide [1]	22,868	2,011,761	88	20,506	2,018,935	98
Lithopone	140,831	11,751,500	83	145,565	12,235,624	84
Zinc chloride, 50° B	32,187	1,459,745	45	17,555	786,462	45
Zinc sulphate	5,698	221,780	39	6,783	288,180	42

[1] Zinc oxide containing 5 percent or more lead is classed as leaded zinc oxide.

Zinc pigments and salts sold by domestic manufacturers in the United States, 1925–34, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° B.)	Zinc sulphate
1925	151,354	31,750	145,019	45,619	5,593
1926	146,923	23,859	159,931	47,296	6,612
1927	151,246	26,064	176,994	40,141	6,418
1928	160,904	24,223	200,468	45,669	4,733
1929	160,611	27,149	206,315	43,189	7,454
1930	119,142	17,279	164,065	29,043	6,249
1931	95,700	18,577	151,850	34,885	5,290
1932	72,250	14,305	121,667	23,524	4,252
1933	98,542	22,868	140,831	32,187	5,698
1934	87,088	20,506	145,565	17,555	6,783

CONSUMPTION BY INDUSTRIES

White lead.—Over 95 percent of the white lead produced is used in the manufacture of paint. The tonnage used in 1934 was 10 percent above that in 1933 and 45 percent below that in 1929. Consumption of white lead in the ceramic industry decreased 11 percent in 1934.

Distribution of white lead (dry and in oil) sales, 1931–34, by industries

Industry	1931		1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paint	91,832	94.3	63,399	95.1	68,368	93.7	75,008	95.3
Ceramics	2,848	2.9	1,761	2.6	1,617	2.2	1,434	1.8
Other	2,688	2.8	1,514	2.3	2,997	4.1	2,292	2.9
	97,368	100.0	66,674	100.0	72,982	100.0	78,734	100.0

Basic lead sulphate.—This pigment is used largely in paint, and the quantity so used in 1934 was 7 percent below that in 1933 and 51 percent below that in 1929. In 1929 over 2,000 tons of basic lead sulphate were used in storage batteries, but this use has declined to small tonnages during the depression.

Distribution of basic lead sulphate sales, 1931–34, by industries

Industry	1931		1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints	8,311	85.8	5,689	90.9	7,072	89.0	6,611	93.5
Storage batteries	697	7.2	195	3.1	99	1.3	139	2.0
Rubber	173	1.8	77	1.2	161	2.0	93	1.3
Other	505	5.2	296	4.8	613	7.7	224	3.2
	9,686	100.0	6,257	100.0	7,945	100.0	7,067	100.0

Litharge.—The principal use of litharge is in the manufacture of storage batteries, but this outlet has been affected adversely by the growing tendency of battery makers to substitute a black oxide, or suboxide, of lead, which they manufacture themselves. This practice began in 1923, and by 1929 a total of 33,000 tons of the black oxide was being made. In 1931 the tonnage declined to about 23,000, but since then has increased again to nearly 33,000 in 1934, which was more than the quantity of litharge used by battery manufacturers in that year. In 1934 all major uses of litharge increased except rubber manufacture.

Distribution of litharge sales, 1931–34, by industries

Industry	1931		1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Storage batteries	31,605	49.5	29,365	50.5	27,327	44.6	30,024	43.7
Insecticides	7,508	11.8	11,735	20.2	11,126	18.2	12,271	17.9
Oil refining	7,351	11.5	4,793	8.3	6,070	9.9	7,614	11.1
Ceramics	4,124	6.5	2,963	5.1	5,438	8.9	6,696	9.7
Chrome pigments	3,582	5.6	2,591	4.5	3,973	6.5	6,162	9.0
Rubber	3,032	4.7	1,921	3.3	2,875	4.7	2,466	3.6
Varnish	641	1.0	1,360	2.3	610	1.0	414	.6
Linoleum	208	.3	169	.3	106	.2	104	.1
Other	5,839	9.1	3,199	5.5	3,668	6.0	2,982	4.3
	63,890	100.0	58,096	100.0	61,193	100.0	68,733	100.0

Red lead.—The use of red lead in storage batteries increased 23 percent and in paint 22 percent in 1934 over 1933.

Distribution of red lead sales, 1931–34, by industries

Industry	1931		1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Storage batteries	13,700	53.0	10,655	56.4	12,949	58.9	15,987	59.8
Paints	9,256	35.8	6,389	33.8	7,182	32.7	8,766	32.8
Ceramics	811	3.1	467	2.5	715	3.2	595	2.2
Other	2,086	8.1	1,369	7.3	1,142	5.2	1,395	5.2
	25,853	100.0	18,880	100.0	21,988	100.0	26,743	100.0

Orange mineral.—Sales of orange mineral increased slightly in 1934.

Distribution of orange mineral sales, 1931–34, by industries

Industry	1931		1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ink manufacture	119	42.2	58	27.4	18	7.8	24	10.2
Color pigments	114	40.4	108	50.9	96	41.6	68	29.1
Other	49	17.4	46	21.7	117	50.6	142	60.7
	282	100.0	212	100.0	231	100.0	234	100.0

Zinc oxide.—Total sales of zinc oxide declined 12 percent in 1934 due largely to the 7 percent decrease in sales to the rubber industry and the 19 percent drop in sales to the paint industry, the two principal consumers. Floor coverings and textiles, and ceramics took more zinc oxide in 1934 than in 1933 but this increase was more than offset by a large decline in sales to miscellaneous users.

Distribution of zinc oxide sales, 1931–34, by industries

Industry	1931		1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Rubber	47,972	50.1	37,679	52.1	53,869	54.7	50,145	57.6
Paints	31,357	32.8	22,369	31.0	29,218	29.7	23,741	27.3
Floor coverings and textiles	4,695	4.9	2,837	3.9	4,087	4.1	4,781	5.5
Ceramics	3,171	3.3	1,782	2.5	2,639	2.7	2,963	3.4
Other	8,505	8.9	7,583	10.5	8,729	8.8	5,458	6.2
	95,700	100.0	72,250	100.0	98,542	100.0	87,088	100.0

Leaded zinc oxide.—This pigment is used almost entirely in the manufacture of paint. The quantity sold for that purpose in 1934 was 9 percent less than in 1933.

Distribution of leaded zinc oxide sales, 1931–34, by industries

Industry	1931		1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints	18,292	98.5	14,072	98.4	22,488	98.3	20,376	99.4
Rubber	38	.2	26	.2	46	.2	28	.1
Other	247	1.3	207	1.4	334	1.5	102	.5
	18,577	100.0	14,305	100.0	22,868	100.0	20,506	100.0

Lithopone.—Sales of lithopone to the paint industry increased 7 percent in 1934. About 8,200 tons of lithopone were used in the manufacture of titanated lithopone in 1934 compared with 5,500 tons in 1933. Sales of high-strength lithopone increased 37 percent, whereas those of regular lithopone increased only 2 percent. Floor coverings and textiles took 20 percent less and rubber 9 percent less lithopone in 1934 than in 1933. Lithopone production capacity was reported at 232,320 tons per year in 1934 compared with 233,320 tons in 1933.

Distribution of lithopone sales, 1930–34, by industries

Industry	1930 (short tons)	1931 (short tons)	1932 (short tons)	1933 (short tons)	1934	
					Short tons	Percent of total
Paints, etc.	126,076	119,446	93,465	106,995	114,472	78.6
Floor coverings and textiles	23,656	20,780	17,601	18,472	14,811	10.2
Rubber	5,997	5,833	3,955	5,078	4,596	3.2
Other	8,336	5,791	6,646	10,286	11,686	8.0
	164,065	151,850	121,667	140,831	145,565	100.0

Zinc chloride.—According to the Department of Agriculture the consumption of zinc chloride by wood-treating plants declined in 1934 notwithstanding a substantial increase in the total quantity of wood treated. From a peak of 26,000 tons (solid basis) in 1921 consumption of zinc chloride in this field declined to 12,000 tons in 1928, 2,500 tons in 1933, and 1,600 tons in 1934. The loss of this market is due primarily to the fact that zinc chloride is soluble in water and therefore is not as effective as creosote, its principal competitor, in preserving wood exposed to moisture. From time to time various insoluble zinc preservatives have been developed, none of which has found a wide market. Recently a chromated zinc was introduced, but enough time has not elapsed to gage its effect on this market for zinc.

Zinc sulphate.—In 1933, the latest year for which data are available, 492 tons of zinc sulphate were used as a depressant in the flotation of lead-zinc ores. This compares with 408 tons in 1932 and 1,425 tons in 1929.

RAW MATERIALS USED IN THE MANUFACTURE OF LEAD AND ZINC PIGMENTS AND SALTS

Lead pigments and zinc pigments and salts are manufactured from a variety of materials, including ore, refined metal, and miscellaneous secondary materials, such as scrap and waste from various industrial processes. In 1934, 95.2 percent of the lead in lead pigments was derived from pig lead, 4.6 percent from ore, and 0.2 percent from secondary material. For zinc pigments and salts the proportions were 63.3 percent from ore, 21 percent from slab zinc, and 15.7 percent from secondary materials.

Metal content of lead pigments and zinc pigments and salts produced by domestic manufacturers, 1933–34, by sources, in short tons

Source	1933		1934	
	Lead in pigments[1]	Zinc in pigments and salts	Lead in pigments[1]	Zinc in pigments and salts
Domestic ore	6, 875	71, 622	7, 538	76, 331
Metal	143, 027	32, 916	157, 294	25, 391
Secondary material[2]	56	21, 798	379	18, 913
	149, 958	126, 336	165, 211	120, 635

[1] Includes also lead recovered in zinc oxide and leaded zinc oxide. The metal content of lead acetate and lead arsenate is not available as no canvass of their production is made by the Bureau of Mines. Moreover, these salts are derived from pig lead, and their metal content has already been taken into statistical account in the figures covering lead production.
[2] Zinc ashes, skimmings, drosses, and old metal.

In the following tables the source of the metal used in the manufacture of each pigment and salt is given. Pig lead is used exclusively, either directly or indirectly, in the manufacture of white lead, litharge, red lead, and orange mineral and to a large extent in the manufacture of basic lead sulphate. Zinc oxide is the only pigment in which considerable slab zinc is used. Ore is employed in the manufacture of zinc oxide, leaded zinc oxide, lithopone, zinc sulphate, and basic lead sulphate. Some secondary lead is used in the manufacture of basic lead sulphate, and a substantial proportion of the zinc in lithopone and zinc chloride made in the United States is derived from secondary material. There was a large increase in the quantity of zinc drosses used in the manufacture of zinc oxide in 1933 and 1934 over 1932. The decided drop in the use of slab zinc in 1934 compared with 1933 was due to the sharp decline in production of French-process zinc oxide.

Lead content of lead and zinc pigments produced by domestic manufacturers, 1933–34, by sources, in short tons

Pigment	1933				1934			
	Lead in pigments produced from—			Total lead in pigments	Lead in pigments produced from—			Total lead in pigments
	Domestic ore	Pig lead	Secondary material		Domestic ore	Pig lead	Secondary material	
White lead		60, 469		60, 469		63, 593		63, 593
Red lead		20, 060		20, 060		24, 972		24, 972
Litharge		56, 469		56, 469		66, 690		66, 690
Orange mineral		136		136		142		142
Basic lead sulphate	1, 908	5, 893		7, 801	2, 789	1, 897		4, 686
Leaded zinc oxide	4, 967		56	5, 023	4, 749		379	5, 128
Zinc oxide								
	6, 875	143, 027	56	149, 958	7, 538	157, 294	379	165, 211

Zinc content of zinc pigments and salts produced by domestic manufacturers, 1933–34, by sources, in short tons

Pigment or salt	1933				1934			
	Zinc in pigments and salts produced from—			Total zinc in pigments and salts	Zinc in pigments and salts produced from—			Total zinc in pigments and salts
	Domestic ore	Slab zinc	Secondary material		Domestic ore	Slab zinc	Secondary material	
Zinc oxide	42,110	32,784	2,848	77,742	42,804	25,371	3,355	71,530
Leaded zinc oxide	10,913	31	118	11,062	11,478		95	11,573
Lithopone	[1] 17,749		11,288	[1] 29,037	[1] 20,519		10,836	[1] 31,355
Zinc chloride		101	6,680	6,781		19	4,216	4,235
Zinc sulphate	850		864	1,714	1,530	1	411	1,942
	71,622	32,916	21,798	126,336	76,331	25,391	18,913	120,635

[1] Includes zinc content of a small quantity of zinc sulphide produced.

PRODUCERS AND PLANTS

The chapter on Lead and Zinc Pigments and Zinc Salts in Minerals Yearbook, 1934, page 132, contains a list of producers of the various products covered in this report, to which should be added the following producers of zinc oxide: Federated Metals Corporation, Trenton, N. J.; Metals Recovery Co., Richmond, Calif.; Monsanto Chemical Co., East St. Louis, Ill.; and Superior Zinc Corporation, Bristol, Pa.

PRICES

The total value and the average price received by producers from sales of lead and zinc pigments and salts are stated earlier in this chapter. The range of market quotations, as reported by the Oil, Paint and Drug Reporter, appears in the following table.

Range of quotations on lead pigments and zinc pigments and salts at New York (or delivered in the East), 1932–34, in cents per pound

Product	1932	1933	1934
Basic lead sulphate, or sublimed lead, less than car lots, barrels	5.50– 6.00	5.50– 6.00	6.25
White lead, or basic lead carbonate, dry, car lots, barrels	6.00– 6.50	6.00– 6.50	6.25– 6.50
Litharge, commercial, powdered, barrels	5.25– 6.00	5.50– 7.00	6.00– 6.75
Red lead, dry, 95 percent or less, less than car lots, barrels	6.25– 7.00	6.50– 8.00	7.00– 7.75
Orange mineral, American, small lots, barrels:			
Ex-white lead	8.75–10.75	10.25–11.75	10.75–11.50
Ex-red lead		9.00–10.50	9.50–10.25
Zinc oxide:			
American process, lead-free, bags, car lots [1]	5.75– 6.50	5.75	5.75– 6.50
American process, leaded, barrels, car lots [1]	5.75– 6.50	5.75	5.75– 6.50
French process, red seal, bags, car lots [1]	8.63– 9.75	8.63	8.38
French process, green seal, bags, car lots [1]	9.63–10.38	9.63	9.38
French process, white seal, barrels, car lots [1]	10.88–11.63	10.88	10.63
Lithopone, domestic, 5-ton lots, bags [1]	4.50	4.50	4.50
Zinc sulphide, less than car lots, bags, barrels	13.00–13.50	13.00–13.50	10.50–13.25
Zinc chloride, works:			
Solution, tanks	3.00	2.00– 3.00	2.00
Fused, drums	5.00– 5.75	4.25– 5.75	4.25– 5.75
Zinc sulphate, crystals, barrels	3.00– 3.50	2.75– 3.75	2.65– 4.50

[1] From Jan. 1 through June 3, 1932, reported as car lots; from June 4, 1932, through Dec. 30, 1933, reported as 2-ton lots.

FOREIGN TRADE[2]

Imports of lead and zinc pigments and salts decreased 32 percent in 1934, and exports increased 42 percent, so that the export surplus increased to over $400,000 compared with $336,000 in 1932 and over $3,000,000 in 1929. In 1933 there was an apparent import surplus.

The following table shows the value of the various pigments and salts imported and exported for 1933–34.

Value of foreign trade of the United States in lead and zinc pigments and salts, 1933–34

	1933		1934	
	Imports	Exports	Imports	Exports
Lead pigments:				
White lead	$460	$120, 433	$2, 790	$202, 683
Red lead	109	63, 638		95, 521
Litharge		142, 890	6	106, 010
Orange mineral	1, 566	(1)	992	(1)
Total	2, 135	326, 961	3, 788	404, 214
Zinc pigments:				
Zinc oxide	247, 241	122, 101	148, 792	195, 681
Lithopone	313, 341	107, 923	219, 752	199, 508
Zinc sulphide	6, 718		4, 062	
Total	567, 300	230, 024	372, 606	395, 189
Lead and zinc salts:				
Lead arsenate	58	44, 808		53, 054
All lead compounds [2]	37, 177		25, 580	
Zinc chloride	24, 720		23, 990	
Zinc sulphate	8, 454		7, 660	
All zinc compounds [2]		(3)		(3)
Total	70, 409	[4] 44, 808	57, 230	[4] 53, 054
Grand total	639, 844	[4] 601, 793	433, 624	[4] 852, 457

[1] Orange mineral included with red lead in 1933, but data not available in 1934.
[2] Excluding pigments. Salts not classified separately.
[3] Figures not available.
[4] Exclusive of the value of "all zinc compounds", figures for which are not available.

Lead pigments and salts.—Imports of these commodities are of negligible proportions. The most important item is the group of lead compounds, including lead acetate, lead nitrate, and others.

Lead pigments and salts imported for consumption in the United States, 1929–34, in short tons

Year	Basic carbonate white lead	Red lead	Litharge	Orange mineral	Lead compounds	Total value
1929	98	5	2	26	293	$76, 023
1930	74	10	(1)	13	297	66, 727
1931	68	(1)	(1)	12	290	61, 533
1932	29	4		4	277	52, 865
1933	3	1		10	268	39, 312
1934	15		(1)	5	183	29, 368

[1] Less than 1 ton.

[2] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

The principal exports are white lead, litharge, red lead, and lead arsenate. Less than 2 percent of the domestic production of white lead, red lead, and litharge was exported in 1934. Shipments of white lead to foreign countries were 49 percent higher in 1934, those of red lead were 31 percent higher, and those of litharge were 37 percent lower than in 1933. Canada took over half of the red lead and litharge exported in 1933 but only 24 percent of the 1934 total.

Lead pigments and salts exported from the United States, 1929–34, in short tons

Year	White lead	Red lead [1]	Litharge	Lead arsenate	Other lead compounds	Total value
1929	5,908	2,890	(2)	782	----------	$1,616,937
1930	6,546	4,128	(2)	1,135	----------	1,777,169
1931	5,008	3,087	(2)	894	----------	1,123,369
1932	1,681	493	1,493	595	----------	461,694
1933	1,048	570	1,538	299	----------	371,769
1934	1,561	745	972	325	----------	457,273

[1] Includes litharge from 1929 to 1931 and an unknown quantity of orange mineral, 1929 to 1933.
[2] Included with red lead.

White lead and red lead, orange mineral,[1] and litharge exported from the United States, by destinations, 1931–34, in short tons

Destination	White lead				Red lead, orange mineral,[1] and litharge			
	1931	1932	1933	1934	1931	1932	1933	1934
Countries:								
Argentina	67	31	60	69	103	63	109	232
Canada	81	23	75	91	1,935	1,268	1,104	415
Netherlands	361	387	377	463	37	4	--------	--------
Netherland West Indies	1	3	2	10	(2)	3	58	(2)
Panama	1	201	26	201	76	2	68	112
Philippine Islands	112	145	138	130	86	105	164	210
United Kingdom	4,235	743	73	47	233	26	17	3
Others	150	148	296	550	617	515	588	745
Total	5,008	1,681	1,047	1,561	3,087	1,986	2,108	1,717
Continents:								
North America	152	326	223	477	2,117	1,379	1,404	759
South America	83	75	150	177	223	218	210	346
Europe	4,619	1,131	479	590	490	197	213	232
Asia	123	148	141	(2)	217	170	201	40
Africa	30	(2)	53	167	40	21	80	118
Oceania	1	1	1	150	(2)	1	(2)	222

[1] Orange mineral is not included in this group in 1934. Data not available.
[2] Less than 1 ton.

Zinc pigments and salts.—Imports of zinc oxide and lithopone declined 50 and 30 percent, respectively, in 1934. Of the zinc oxide, 41 percent came from the United Kingdom, 26 percent from France, and 21 percent from Belgium, and the Netherlands supplied 98 percent of the lithopone. Germany supplied 88 percent of the zinc chloride imported in 1934.

Zinc pigments and salts imported for consumption in the United States, 1929–34, in short tons

Year	Zinc oxide		Litho-pone	Zinc sulphide	Zinc chloride	Zinc sulphate	Total value
	Dry	In oil					
1929	1, 267	110	8, 409	315	638	909	$1, 122, 490
1930	1, 056	79	7, 018	80	351	519	831, 284
1931	1, 352	105	5, 674	67	278	208	662, 706
1932	2, 515	157	4, 724	33	251	131	539, 380
1933	2, 359	182	5, 596	27	431	193	600, 474
1934	1, 204	64	3, 927	12	382	140	404, 256

Exports of zinc oxide and lithopone increased 60 and 102 percent, respectively, due largely to increased shipments to Canada and other North American countries. Canada was the principal consumer but took only 6 percent as much zinc oxide and 46 percent as much lithopone as in 1929.

Zinc pigments and salts exported from the United States, 1929–34, in short ton

Year	Zinc oxide	Litho-pone	Zinc salts	Total value	Year	Zinc oxide	Litho-pone	Zinc salts	Total value
1929	17, 638	4, 556	1, 711	$2,919,140	1932	1, 261	3, 212	299	$512, 559
1930	10, 753	3, 665	1, 558	1, 956, 085	1933	722	1, 186	(1)	[2] 230, 024
1931	5, 131	3, 821	1, 011	1, 146, 395	1934	1, 155	2, 401	(1)	[2] 395, 189

[1] Zinc salts not separately recorded.
[2] Exclusive of value of zinc salts.

Zinc oxide and lithopone exported from the United States, by destinations, 1931–34, in short tons

Destination	Zinc oxide				Lithopone			
	1931	1932	1933	1934	1931	1932	1933	1934
Countries:								
Argentina	171	79	16	36	12	19	12	33
Canada	2, 818	740	286	439	3, 318	2, 883	881	1, 803
Cuba	58	23	22	87	100	82	41	185
France	1	4	5	12	--------	(1)	--------	1
United Kingdom	1, 523	97	36	68	232	89	132	104
Others	560	318	357	513	159	139	120	275
Total	5, 131	1, 261	722	1, 155	3, 821	3, 212	1, 186	2, 401
Continents:								
North America	2, 998	904	437	856	3, 466	2, 983	975	2, 046
South America	217	94	39	48	33	44	54	116
Europe	1, 713	116	72	66	236	95	133	125
Asia	93	61	80	41	26	1	3	1
Africa	8	5	3	12	--------	1	1	--------
Oceania	102	81	91	132	60	88	20	113

[1] Less than 1 ton.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA, IDAHO, AND MONTANA[1]

(MINE REPORT)

By C. N. GERRY, T. H. MILLER, AND PAUL LUFF

SUMMARY OUTLINE

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly U. S. Government prices.[2] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

[2] The Treasury from Feb. 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to Jan. 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

ARIZONA

The output of gold, silver, copper, lead, and zinc from Arizona ores and gravels in 1934, in terms of recovered and estimated recoverable metals, was 165,000 fine ounces of gold, 4,420,000 fine ounces of silver, 177,066,000 pounds of copper, 6,600,000 pounds of lead, and 1,779,000 pounds of zinc. These figures compare with a production in 1933 of 79,992.61 ounces of gold, 2,390,363 ounces of silver, 114,041,781 pounds of copper, 3,442,540 pounds of lead, and 11,024 pounds of zinc.

The chief factors that affected production in 1934 were: The resumption of mining and milling of copper ore at the New Cornelia branch of the Phelps Dodge Corporation and at the property of the Miami Copper Co.; the large increase in production of gold, silver, and copper at the Copper Queen branch of the Phelps Dodge Corporation; the resumption of mining and milling of gold ores at the Tom Reed mine; the construction and operation of new milling plants treating gold ores at the Hillside, Mammoth, Gladstone-McCabe (Harbud), Sheeptanks, and Gold Standard properties; the resumption of mining and milling of lead-zinc ore at the Montana group of the Eagle-Picher Mining & Smelting Co.; the operation of the floating dredge on Lynx Creek by the Lynx Creek Placer Mine Co.; and the large increase in production of gold from the Lake Superior & Arizona property.

Mine production of gold, silver, copper, lead, and zinc in Arizona, 1930–34, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1930	19,802,919	169,390.38	5,540,732	576,190,607	8,491,623	1,630,506	$81,042,416
1931	13,690,610	126,185.94	3,245,311	401,344,909	1,964,112		40,144,694
1932	4,414,579	66,789.67	2,082,823	182,491,825	2,364,300		13,535,935
1933	995,728	79,992.61	2,390,363	114,041,781	3,442,540	11,024	[1] 10,307,749
1934 [2]	3,220,000	165,000.00	4,420,000	177,066,000	6,600,000	1,779,000	23,110,101

[1] Change in value from chapter on Arizona in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).
[2] Subject to revision.

Gold.—The mine production of gold in Arizona in 1934 was more than double that in 1933. This large gain was due chiefly to increased output of copper ore and siliceous gold ore. About 45 percent of the gold output in Arizona in 1934 was recovered from siliceous gold ore and old tailings and 45 percent from copper ore; most of the remainder came from placers, lead ore, and lead-zinc ore. A large number of mills to treat gold ores either were constructed or under construction in 1934.

The largest producers of gold in Arizona in 1934 were the Copper Queen branch of the Phelps Dodge Corporation at Bisbee, the Lake Superior & Arizona Lease at Superior, the New Cornelia mine at Ajo, the Tom Reed mine at Oatman, the United Verde Extension mine at Jerome, the Magma mine at Superior, the Big Jim mine at Oatman, the Gold Standard (Roadside and Arabian mines) at Katherine, the Sheeptanks mine near Vicksburg, the Hillside mine near Hillside, the Gladstone-McCabe property near Prescott, the

Tombstone group (Bunker Hill) at Tombstone, the United American mine at Oatman, the Montana group at Ruby, the dredge of the Lynx Creek Placer Mine Co. near Prescott, the Molybdenum Gold (New Year and Mammoth mines) near Mammoth, the Ace mine southeast of Phoenix, and the Tyro mine at Katherine. These mines yielded about 133,300 ounces of gold, or 81 percent of the State total. The Katherine mill of the Gold Standard Mines Corporation was destroyed by fire in September, but the company constructed a new 300-ton cyanide plant which began to treat ore in November. The dredge on Lynx Creek worked by the Calari Dredging Co. in 1933 was operated in 1934 by the Lynx Creek Placer Mine Co., and considerable gold was produced.

Silver.—The silver output in Arizona increased from 2,390,363 ounces in 1933 to about 4,420,000 ounces in 1934 and the total value from $836,627 to $2,857,374, as the average price rose from 35 to 64.6+ cents an ounce. About 77 percent of the silver produced in Arizona in 1934 came from copper ore from the Copper Queen branch at Bisbee, the Magma mine at Superior, the United Verde Extension mine at Clemenceau, and the New Cornelia mine at Ajo. Lead ore and siliceous ore from the Tombstone Development property at Tombstone, lead-zinc ore from the Montana mine at Ruby, and gold ore from the Hillside mine near Hillside supplied considerable silver. Six mines in Arizona produced more than 100,000 ounces of silver each in 1934—the Copper Queen branch of the Phelps Dodge Corporation, the Magma property at Superior, the United Verde Extension mine at Jerome, and the Tombstone Development, Montana, and New Cornelia mines.

Copper.—The copper output in Arizona rose from 114,041,781 pounds in 1933 to about 177,066,000 pounds in 1934, or 55 percent, and the total value from $7,298,674 to about $14,165,280, as the average sales price increased from 6.4 to 8 cents a pound. The copper smelters at Douglas, Clemenceau, and Superior continued operations during 1934, but the smelting plants at Hayden, Clifton, Miami, and Clarkdale remained idle. The Copper Queen branch of the Phelps Dodge Corporation at Bisbee increased its output of copper 26 percent and was again the largest producer of copper in Arizona; it was followed by the Magma mine at Superior where there was also a marked increase in copper production, the New Cornelia property at Ajo where work in the mine and concentrator was resumed in July, and the Miami Copper Co. which resumed milling in July. The Miami Copper Co. produced two classes of concentrates in 1934—sulphide copper concentrates shipped to the International smelter at Miami for storage and cement copper concentrates shipped to Douglas for smelting.

Lead.—The lead production in Arizona increased from 3,442,540 pounds in 1933 to about 6,600,000 pounds in 1934 and the total value from $127,374 to about $244,200; the average sales price remained at 3.7 cents a pound. The Eagle-Picher Mining & Smelting Co., which owns the Montana group at Ruby, resumed the milling of lead-zinc ore in August in its 300-ton flotation concentrator. The company shipped a large quantity of lead concentrates and zinc concentrates the last 5 months of the year and was the largest producer of lead and zinc in Arizona. Next in order of lead output were the Tombstone Extension property, operated the first half of the year by the American Smelting & Refining Co. and the rest of the year by the Tombstone Extension Mining Co., and the Tombstone group (Bunker Hill property) operated by the Tombstone Development Co. Other producers of lead were the "79" mine in Gila County near Winkelman and the Golden Belt and Golden Turkey mines in Yavapai County near Cordes. Nearly all the lead ore and concentrates from Arizona in 1934 were smelted at El Paso, Tex.

Zinc.—Zinc production in Arizona was resumed late in 1934 through activity of the Eagle-Picher Mining & Smelting Co. at its Montana mine, idle since April 1930. More than 35,000 tons of lead-zinc ore containing appreciable amounts of gold and silver were milled during the last 5 months of the year, and both lead concentrates and zinc concentrates were shipped to smelting plants in Texas.

Ore output.—In 1934 mines and dumps in Arizona produced about 3,220,000 tons of ore, old tailings, etc., or 2,224,000 tons more than in 1933. This large increase resulted chiefly from the resumption of milling of copper ore at the New Cornelia and Miami properties and from the increase in output of copper ore from the Copper Queen branch of the Phelps Dodge Corporation. There was also a large increase in output of gold ore from the mines at Oatman, Katherine, and Mammoth and from mines near Prescott, Hillside, Wickenburg, Vicksburg, and Superior. The output of lead ore also increased, and most of it came from mines at Tombstone and Cordes. There was also a large increase in output of lead-zinc ore, chiefly from the Montana mine at Ruby. About 88 percent of the total ore, old tailings, etc., produced in Arizona in 1934 was copper material, and nearly 9 percent was gold ore and old tailings. Most (75 percent) of the copper material was concentrated, and most of the gold ore and old tailings were treated in cyanidation plants. The greater part of the lead material was ore shipped crude to the smelter at El Paso, Tex. All the lead-zinc ore was treated in concentration plants by flotation. The copper smelting plants at Douglas, Clemenceau, and Superior continued to receive company ore and custom material, but other smelting plants were idle. Receipts at Douglas were considerably larger, chiefly ore and concentrates from the Phelps Dodge properties; receipts at the Magma smelter also increased although the plant was idle about 1 month.

Review of districts and operations.—In 1934 production was resumed in the Ajo and Globe-Miami districts, both important producing areas in the past, and there was considerable increase in the Warren district. The output of the Verde (Jerome) district, formerly the largest producer of gold, silver, and copper in Arizona, was reduced materially in 1934, not only because of the inactivity of the United Verde Copper Co. but also because of depletion of ore reserves at the United Verde Extension mine. The increase in copper ore and gold ore from the Pioneer (Superior) district in 1934 was notable; consequently, the Magma smelter was active most of the year. Both the Ray mine (Mineral Creek district) and the Morenci mine (Copper Mountain district), important copper producers in the past, remained inactive in 1934. There were marked increases in gold from the San Francisco (Oatman) district in Mohave County, including the Katherine section; the Lynx Creek, Eureka (Hillside), Big Bug, Humbug, and Hassayampa districts in Yavapai County; and the Kofa (Sheeptanks) district in Yuma County. Production of gold in the Vulture district, Maricopa County, was upheld; and in Pinal County the Molybdenum Gold property in the Old Hat (Oracle and Mammoth) district increased its gold output substantially in 1934. In addition to the large increase in silver from copper-producing districts there were important increases in silver from lead ore and lead-zinc ore in the Tombstone and Oro Blanco districts.

IDAHO

The output of gold, silver, copper, lead, and zinc from Idaho ores and gravels in 1934, in terms of recovered and estimated recoverable metals, was 83,600 fine ounces of gold, 7,410,000 fine ounces of silver, 1,530,000 pounds of copper, 142,000,000 pounds of lead, and 50,000,000 pounds of zinc. These figures compare with a production in 1933 of 64,592.23 ounces of gold, 6,987,960 ounces of silver, 1,562,234 pounds of copper, 148,726,701 pounds of lead, and 41,935,977 pounds of zinc.

The chief factors that affected production in 1934 were: The large increase in production of gold from lode and placer mines, particularly from the Boise-Rochester lode mine at Atlanta in Elmore County and from lode and placer mines in the Boise Basin district in Boise County; the large production of gold from the two dredges at Warren in Idaho County; the large increase in production of silver from the Sunshine mine (the largest producing silver mine in the United States) near Kellogg; the increased production of silver, lead, and zinc from nearly all the mines in the Coeur d'Alene region; the substantial decrease in output of lead ore from the Bunker Hill & Sullivan property; and the large production of silver-lead ore from the Clayton (Camp Bird) mine, an important producer in Custer County in 1934.

Mine production of gold, silver, copper, lead, and zinc in Idaho, 1930–34, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1930	1,944,900	21,445.07	9,420,639	3,111,555	268,115,963	75,298,172	$21,494,867
1931	1,299,927	18,361.36	7,220,923	1,144,915	198,729,228	39,137,212	11,418,013
1932	1,032,853	46,885.39	6,716,968	1,143,381	144,235,067	20,504,234	7,877,604
1933	1,190,851	64,592.23	6,987,960	1,562,234	148,726,701	41,935,977	[1] 11,460,945
1934 [2]	1,300,000	83,600.00	7,410,000	1,530,000	142,000,000	50,000,000	15,238,523

[1] Change in value from chapter on Idaho in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).
[2] Subject to revision.

Gold.—The mine output of gold in Idaho in 1934 was about 83,600 ounces, an increase of 29 percent over 1933. The total value of the output was $2,921,820 in 1934, at $34.95 per fine ounce, compared with $1,650,977 in 1933, at $25.56 per ounce. Of the increase of more than 19,000 ounces in gold output, most came from lode mines; the output from placers (about 26,300 ounces) increased 13 percent, due chiefly to the large increase in output of gold from property operated by McFarland & Witham near Placerville, Boise County. More than half the placer yield was produced by the two dredges at Warren, Idaho County; the output of these dredges, however, was nearly 10 percent less than in 1933, as production by the Idaho Gold Dredging Co. decreased about 2,000 ounces, whereas that by the Warren Creek Dredging Co. increased slightly. The Boise-Rochester lode property of the St. Joseph Lead Co. in Elmore County, by far the largest gold producer in Idaho in 1934, increased its output more than 11,000 ounces over 1933. Substantial increases in lode-mine gold were also made at the Talache at Quartzburg, the Come Back at Pioneerville, the Four Square at Murray, the Golden Chariot at Silver City, and the Grunter group at Shoup; a decrease of about 1,700 ounces was reported at the Gnome property near Elk City. The Yellow Pine Co. at Stibnite, Valley County, produced about the same quantity of gold in 1934 as in 1933 and retained its position as the second largest gold producer in the State. The Idaho Gold Dredging Co. ranked third and the Warren Creek Dredging Co. fourth. Other large producers of gold were the McFarland & Witham placers in Boise County and the Gnome, Lone Pine, Come Back, and Talache lode mines.

Silver.—Idaho was again the largest producer of silver in the United States, followed again by Utah. The output of silver in Idaho in 1934 was about 7,410,000 ounces compared with 6,987,960 ounces in 1933; the total value increased from $2,445,786 in 1933 to $4,790,303 in 1934, due chiefly to the increase in average price from 35 to 64.6+ cents an ounce. There was a decrease of about 450,000 ounces in silver from the Bunker Hill & Sullivan mine at Kellogg, but substantial increases were made at all other large producers of silver in the State. The Sunshine Mining Co. east of Kellogg increased its silver output more than 300,000 ounces and was again the largest silver producer in the United States. In fact, nearly half the total silver produced in Idaho in 1934 came from the Sunshine property. Other large producers of silver were the Hecla, Bunker Hill & Sullivan, Morning, Crescent, Boise-Rochester (Elmore County), Page, Golconda, and Gold Hunter mines. Mines in the Coeur d'Alene region produced about 7,050,000 ounces of silver in 1934, 95 percent of the State total, compared with 6,762,537 ounces in 1933.

Copper.—The output of copper in Idaho decreased slightly, from 1,562,234 pounds valued at $99,983 in 1933 to about 1,530,000 pounds valued at $122,400 in 1934. Nearly all the copper produced in Idaho comes from copper-lead, lead, and lead-zinc ores, and most of it comes from mines in Shoshone County. The Sunshine mine was again the largest producer of copper in the State, followed again by the Bunker Hill & Sullivan, Hecla, Morning, and Crescent mines.

Lead.—Idaho maintained its position as the second largest producer of lead in the United States, although its output decreased from 148,726,701 pounds valued at $5,502,888 in 1933 to about 142,000,000 pounds valued at $5,254,000 in 1934. The decline in quantity was due almost entirely to a decrease of nearly 21,000,000 pounds in output from the property of the Bunker Hill & Sullivan Mining & Concentrating Co. at Kellogg; much smaller decreases were recorded at the Star, Frisco, Crescent, and Hope (Bonner County) mines, but these losses were offset in part by increases at the Hecla, Page, Golconda, Gold Hunter, Morning, Camp Bird (Custer County), and Blackhawk mines. The Bunker Hill & Sullivan mine was again the largest producer of lead in Idaho, followed by the Hecla, Morning, Page, Golconda, Gold Hunter, Blackhawk, and Frisco mines, all in the Coeur d'Alene region. The Camp Bird mine in Custer County, an important producer in 1934, ranked ninth in lead output.

Zinc.—The output of zinc in Idaho was about 50,000,000 pounds valued at $2,150,000 in 1934 compared with 41,935,977 pounds valued at $1,761,311 in 1933. Substantial increases in zinc output were reported at the Bunker Hill & Sullivan, Morning, and Golconda mines and smaller gains at the Page, Hecla, Blackhawk, and Frisco mines. The Star mine of the Sullivan Mining Co., a large producer of zinc in past years, was idle in 1934. The Morning mine of the Federal Mining & Smelting Co. was again the largest producer of zinc in Idaho, followed by the Bunker Hill & Sullivan, Golconda, Frisco, Page, Hecla, and Blackhawk mines, all in the Coeur d'Alene region.

Ore output.—About 1,300,000 tons of ore, old tailings, etc., were produced in Idaho in 1934 compared with 1,190,851 tons in 1933. Lead ore is by far the chief product of mines in Idaho, but the output decreased 3 percent in 1934 compared with 1933. The large increase in output of lead-zinc ore and siliceous gold ore more than offset the decrease in output of lead ore. Nearly half the total ore, old tailings, etc., produced in Idaho in 1934 was lead ore; 28 percent was lead-zinc ore; 15 percent was siliceous gold ore; and nearly all the remainder was copper-lead ore. About 84 percent of the total ore came from mines in the Coeur d'Alene region, Shoshone County, and nearly 10 percent was gold ore from the Boise-Rochester mine in Elmore County and the Yellow Pine mine in Valley County.

Coeur d'Alene region.—The Coeur d'Alene region in Shoshone County is the chief producing area in Idaho. In 1934 mines in this region yielded 95 percent of the State output of silver, 99 percent of the lead, all the zinc, and nearly all the copper. The region produces very little gold but in 1934 yielded more than usual, especially at lode and placer mines near Murray. The total output of the Coeur d'Alene region in 1934 was about 1,090,000 tons of ore yielding, in terms of recovered metals, about 2,800 ounces of gold, 7,050,000 ounces of silver, 1,475,000 pounds of copper, 140,300,000 pounds of lead, and 50,000,000 pounds of zinc compared with an output in 1933 of 1,052,889 tons of ore, etc., yielding 1,584.33 ounces of gold, 6,762,537 ounces of silver, 1,544,343 pounds of copper, 147,851,459 pounds of lead, and 41,916,167 pounds of zinc.

MONTANA

The output of gold, silver, copper, lead, and zinc from Montana ores and gravels in 1934, in terms of recovered and estimated recoverable metals, was 97,822 fine ounces of gold, 3,958,000 fine ounces of silver, 63,250,000 pounds of copper, 19,800,000 pounds of lead, and 61,000,000 pounds of zinc. These figures compare with a production in 1933 of 57,822.20 ounces of gold, 2,660,700 ounces of silver, 65,476,375 pounds of copper, 13,163,432 pounds of lead, and 41,448,905 pounds of zinc.

The chief factors that affected production in 1934 were: The unusually large production of gold by dredging operations on Gold Creek and Ophir Creek in Powell County and on Prickly Pear Creek in Jefferson County; the increase in production of gold from old lode mines; the increase in production of silver, lead, and zinc from mines at Butte and Philipsburg; the large increase in production of lead from the Jack Waite property in Sanders County; and the labor difficulty at Butte which closed the mines and mills from May to September.

Mine production of gold, silver, copper, lead, and zinc in Montana, 1930–34, in terms of recovered metals

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1930	2,686,669	43,489.17	7,052,889	196,187,523	21,306,044	52,841,108	$32,720,416
1931	2,085,683	40,112.16	3,829,837	184,555,735	8,860,186	13,494,986	19,575,053
1932	765,014	40,602.01	1,686,213	84,847,349	2,157,766	4,393,034	6,856,737
1933	862,486	57,822.20	2,660,700	65,476,375	13,163,432	41,448,905	[1] 8,827,569
1934 [2]	1,030,000	97,822.00	3,958,000	63,250,000	19,800,000	61,000,000	14,393,186

[1] Change in value from chapter on Montana in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).
[2] Subject to revision.

Gold.—The mine output of gold in Montana in 1934 was about 97,822 ounces, an increase of 40,000 ounces (69 percent) over 1933. The total value of the output was $3,418,879 in 1934, at $34.95 per fine ounce, compared with $1,477,935 in 1933, at $25.56 per ounce. The large increase in quantity was due chiefly to the unusual production from dredging operations in Powell and Jefferson Counties, and to the substantial increase in production from lode mines in the Bannack district (Beaverhead County), Beaver and Cedar Plains districts (Broadwater County), First Chance and Hidden Lake districts (Granite County), Helena, Ottawa, Scratch Gravel, and Stemple districts (Lewis and Clark County), Mineral Hill, Sheridan, and Tidal Wave districts (Madison County), and Little Rockies district (Phillips County). The largest gold producers in Montana in 1934 were the Pioneer dredge, operated by the Yuba Associated Engineers, Ltd., at Goldcreek and the dredge on Ophir Creek operated by the Yuba Consolidated Gold Fields, both in Powell County. These were followed in order by the Little Ben (August), Jay Gould, Jardine, Winston Bros. (dredge operations on Prickly Pear Creek), Boss Tweed-Clipper, Thompson Gold Milling Co. (formerly I. B.), Anaconda, Gold Coin, Hidden Lake, Prospect, Ohio-Keating, Drumlummon, Liberty Montana, B. & H. (Inspiration), Grant & Hartford, Scratch Gravel, and Spring Hill properties. Notable gains in production of gold were reported by the three dredging companies and from the Standard Silver-Lead (Jay Gould), Little Ben, Thompson (I. B.), Hidden Lake, Drumlummon, Ohio-Keating, B. & H. (Inspiration), Grant & Hartford, and Scratch Gravel properties. Gold ore was treated in cyanidation plants by the Thompson Gold Milling Co., Lakes Mining & Milling Co., and Little Ben Mining Co.; in amalgamation and concentration plants by the Jardine Mining Co., Gold Coin Mines Co., St. Louis Mining & Milling Co., and Virginia City Gold Mining Co.; and in flotation-concentration plants by the Standard Silver-Lead Mining Co., Pacific Gold Mining Co., Liberty Montana Mines Co., and Montana Consolidated Mines Corporation. The Montana Consolidated Mines Corporation constructed a new 250-ton flotation-concentration plant at the Spring Hill mine, and milling operations were begun in October.

Silver.—The output of silver in Montana increased from 2,660,700 ounces in 1933 to about 3,958,000 ounces in 1934 and the value from \$931,245 to \$2,558,707. The increase in price of silver from 35 cents an ounce in 1933 to 64.6+ cents in 1934 brought increased activity to the silver-lead-zinc districts at Butte and Philipsburg and to some of the silver districts. About 48 percent of the total silver came from copper ore and 34 percent from lead-zinc ore; most of the remainder came from silver ore. The Anaconda Copper Mining Co. was, as usual, the chief producer of silver in Montana; its output in 1934 was nearly three fourths of the State total. Next in rank were the Trout, Emma, Flathead, Granite Bimetallic, and Quartz Hill properties. Considerable silver also was produced from mines near Basin, Deer Lodge, Wilborn, and Rimini. The Flathead mine near Kila, owned by the Anaconda Copper Mining Co., and the Granite Bimetallic mine at Philipsburg, both producers of silver ore, were active again after being idle for several years.

Copper.—The copper output in Montana decreased from 65,476,375 pounds in 1933 to about 63,250,000 pounds in 1934, but the total value increased from \$4,190,488 to \$5,060,000 as the average price increased from 6.4 to 8 cents a pound. The Anaconda Copper Mining Co. produced from mines at Butte nearly all the copper produced in the State, but its output was less than in 1933 as the mines were closed from May to September during a period of unsettled labor conditions.

Lead.—The production of lead in Montana increased from 13,163,432 pounds valued at \$487,047 in 1933 to about 19,800,000 pounds valued at \$732,600 in 1934. The gain was due chiefly to the increase in output of lead-zinc ore from the Jack Waite mine in Sanders County and from the mines at Butte operated by the Anaconda Copper Mining Co. There was also a large increase in production of lead from the Trout mine at Philipsburg and from the slag dump at East Helena. The largest producer of lead in Montana in 1934 was the Orphan Girl mine at Butte, owned by the Anaconda Copper Mining Co.; it was followed closely by the Jack Waite and Emma properties. Other large producers of lead were the slag dump at East Helena, the Trout mine at Philipsburg, the Montana Lead, Inc., near Rimini, and the Comet mine near Basin. Nearly all the lead was recovered from lead-zinc ore treated by flotation.

Zinc.—The output of zinc in Montana increased from 41,448,905 pounds in 1933 to about 61,000,000 pounds in 1934 and the value from \$1,740,854 to about \$2,623,000, a gain due chiefly to increased output of lead-zinc ore from the Orphan Girl and Emma properties at Butte, increased production of zinc from the fuming plant at East Helena, and increased output of lead-zinc ore from the Trout property at Philipsburg. The Orphan Girl and Emma properties and the fuming plant are all operated by the Anaconda Copper Mining Co. The Orphan Girl mine was by far the largest producer of zinc in Montana in 1934; it was followed by the fuming plant at East Helena and the Emma and Trout mines. Considerable zinc also was produced from the Josephine mine at Butte, the Jack Waite mine in Sanders County, and the Silver Prince mine at Philipsburg. Most of the zinc was recovered from lead-zinc ore treated in flotation-concentration plants; more than 69 percent of the zinc was produced from mines at Butte and the remainder chiefly from slag at East Helena and from the Trout mine at Philipsburg.

Ore output.—The output of ore, old tailings, etc., in Montana increased from 862,486 tons in 1933 to about 1,030,000 tons in 1934. There was a decrease of about 30,000 tons in copper material, but the large increases in lead-zinc ore, siliceous gold ore, and silver ore more than offset this loss. About 45 percent of the total material was classified as copper ore, 23 percent as lead-zinc ore, and most of the remainder as siliceous gold ore, zinc slag, and silver ore. More than 62 percent of the State total came from mines at Butte.

Butte (Summit Valley) district.—The Butte district is the chief producing district in Montana and in 1934 was the source of more than 71 percent of the State output of silver, 55 percent of the lead, nearly all the copper, and 69 percent of the zinc; very little gold (only about 3 percent of the State total) was produced. Production in the Butte district in 1934, in terms of recovered metals, was about 3,400 ounces of gold, 2,815,000 ounces of silver, 62,853,000 pounds of copper, 10,785,000 pounds of lead, and 42,335,000 pounds of zinc compared with 3,167.74 ounces of gold, 2,356,720 ounces of silver, 65,235,250 pounds of copper, 8,370,243 pounds of lead, and 30,962,929 pounds of zinc in 1933.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA

(MINE REPORT)

By F. W. HORTON AND H. M. GAYLORD [1]

SUMMARY OUTLINE

The output of gold, silver, copper, lead, and zinc from California ores and gravels in 1934, in terms of recovered metals, was 719,063.92 fine ounces of gold, 844,413 fine ounces of silver, 569,068 pounds of copper, 823,168 pounds of lead, and 721,719 pounds of zinc, valued in all at $25,784,183. This output compares with a production in 1933 of 613,578.85 ounces of gold, 402,591 ounces of silver, 990,380 pounds of copper, 761,156 pounds of lead, and 290,214 pounds of zinc, valued at $15,927,718. Gold was the principal metal produced in 1934 and constituted 97.5 percent of the total value of the five metals; silver comprised 2.1 percent and the base metals 0.4 percent of the total. Most of the silver and much of the lead and copper were byproducts of gold mining. There were 867 lode mines and 1,784 placers producing in 1934, an increase of 70 lode mines and 791 placers over 1933. It should be noted that the large increase in number of placers was due to the many small operations with outputs of less than 50 ounces.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly U. S. Government prices.[2] The

[1] Statistics collected by O. Y. Sharman, of the Bureau of Mines; her assistance is gratefully acknowledged.

[2] The Treasury from Feb. 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of Jan. 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to Jan. 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, copper, lead, and zinc in California, 1930–34, in terms of recovered metals

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1930	481	892	1,595,150	457,199.98	$9,451,162	1,622,803	$624,779
1931	462	497	1,497,247	523,135.09	10,814,162	867,818	251,667
1932	718	828	1,060,361	569,166.99	11,765,726	493,533	139,176
1933 [1]	797	993	1,322,100	613,578.85	[2] 15,683,075	402,591	140,907
1934	867	1,784	2,356,091	719,063.92	25,131,284	844,413	545,883

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1930	27,285,272	$3,547,085	3,559,564	$177,978			$13,801,004
1931	12,931,995	1,176,812	3,757,256	139,018	159,865	$6,075	12,387,734
1932	1,417,876	89,326	2,417,416	72,522			12,066,750
1933 [1]	990,380	63,384	761,156	28,163	290,214	12,189	[2] 15,927,718
1934	569,068	45,525	823,168	30,457	721,719	31,034	25,784,183

[1] Figures include copper recovered from copper concentrates produced in 1930 but not marketed until 1933.
[2] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold and silver produced at placer mines in California, 1930–34, in terms of recovered metals

Year	Dredge				Drift			
	Gold		Silver		Gold		Silver	
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
1930	166,980.85	$3,451,801	10,753	$4,140	3,029.01	$62,615	426	$164
1931	175,086.28	3,619,355	10,602	3,075	5,379.26	111,199	687	199
1932	188,830.89	3,903,481	11,269	3,178	9,959.43	205,880	1,166	329
1933	201,710.32	[1] 5,155,716	12,730	4,455	16,981.08	[1] 434,036	1,862	652
1934	194,051.48	6,782,099	12,386	8,007	12,992.78	454,098	1,511	977

[1] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold and silver produced at placer mines in California, 1930–34, in terms of recovered metals—Continued

Year	Hydraulic				Surface				Total value
	Gold		Silver		Gold		Silver		
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value	
1930	4,324.88	$89,403	466	$179	7,320.31	$151,324	981	$378	$3,760,004
1931	3,026.16	62,556	380	110	11,011.90	227,636	1,545	448	4,024,578
1932	5,944.15	122,876	696	196	25,795.39	533,238	3,469	978	4,770,156
1933	4,494.94	[1] 114,890	472	165	38,192.52	[1] 976,201	5,396	1,889	[1] 6,688,004
1934	9,281.75	324,397	1,105	714	57,698.82	2,016,574	8,246	5,331	9,592,197

[1] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold.—In 1934 California produced 719,063.92 fine ounces of gold, an increase of 105,485.07 ounces (17 percent) over 1933, and maintained its position as the leading gold-producing State, exceeding both Alaska and South Dakota in output. The value of the gold produced was $25,131,284 in 1934 compared with $15,683,075 in 1933, an increase of $9,448,209 (60 percent). Approximately 62 percent of the total gold in 1934 came from lode mines and 38 percent from placers. Nevada and Sacramento Counties each produced more than 100,000 ounces and were followed in order by Amador, Yuba, Eldorado, Calaveras, Sierra, and Kern Counties, each with a yield of over 29,000 ounces; these eight counties produced 559,807 ounces (78 percent) of the State total. The major increases in the State in county output were: Nevada County, 20,722 ounces (11 percent); Calaveras, 19,146 ounces (110 percent); Eldorado, 18,342 ounces (87 percent); Kern, 12,634 ounces (76 percent); Sierra, 11,988 ounces (69 percent); and Yuba, 10,971 ounces (25 percent). The only counties in which production dropped appreciably were: Sacramento, 15,510 ounces (13 percent); Amador, 11,033 (14 percent); and Shasta, 3,629 (15 percent). The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—contributed 163,564 ounces (23 percent) of the State total.

In 1934, of the 49 lode mines and 21 placers producing more than 1,000 ounces of gold each, 32 lodes and 14 placers each produced 1,000 to 5,000 ounces, 9 lodes and 4 placers 5,000 to 10,000 ounces, 5 lodes 10,000 to 20,000 ounces, 2 lodes and 1 placer 20,000 to 50,000 ounces, and 1 lode and 2 placers more than 50,000 ounces; these 70 mines produced 597,431 fine ounces of gold—388,921 ounces from lode mines and 208,510 ounces from placers—and accounted for 83 percent of the State total. In 1933 only 27 lode mines and 15 placers produced more than 1,000 ounces each; their total yield of 521,819 ounces—310,916 ounces from lode mines and 210,903 ounces from placers—accounted for 85 percent of the State total.

The yield of lode gold was 445,039 ounces in 1934 compared with 352,200 ounces in 1933, an increase of 92,839 ounces (26 percent). The largest production was from Nevada County (195,059 ounces); next in order were Amador (59,218 ounces), Eldorado (32,938 ounces), Kern (28,294 ounces), and Sierra (26,143 ounces). The following 20 companies (or mines), virtually all old, established operators, produced 75 percent of the total lode gold and 46.5 percent of the total gold output of the State in 1934; listed in order of output, they were as follows: Empire Star Mines Co., Ltd. (Nevada County), Idaho-Maryland Mines Co. (Nevada County), The Argonaut Mining Co., Ltd. (Amador County), Carson Hill Gold Mining Corporation (Calaveras County), The Mountain Copper Co., Ltd. (Shasta County), Original Sixteen to One Mine, Inc. (Sierra County), Kennedy Mining & Milling Co. (Amador County), Montezuma Apex Mining Co. (Eldorado County), Central Eureka Mining Co. (Amador County), Central Tailings Co. (Amador County), Golden Center mine (Nevada County), Beebe Gold Mining Co. (Eldorado County), Lava Cap Gold Mining Corporation (Nevada County), Pacific Mining Co. (Mariposa County), Spanish Mining Co. (Nevada County), Middle Fork Gold Mining Co. (Eldorado County), Silver Queen Mining Co. (Kern County), Kenton mine (Sierra County), Cardinal Gold Mining Co. (Inyo County), and King Solomon Mines Co. (Siskiyou County). The continued increase in average price of gold transformed much vein material too low in grade to be considered ore heretofore into payable reserves which in many instances were increased further by active development work.

Production of gold by dredging in 1934 totaled 194,051.48 fine ounces, approximately 27 percent of the total gold output of the State and 7,658.84 ounces (4 percent) less than the dredge yield in 1933. The Natomas Co. with 6 dredges in the Folsom district (Sacramento County), the Yuba Consolidated Gold Fields with 5 dredges in the Yuba River district (Yuba County) and 1 dredge in the Snelling district (Merced County), and the Capital Dredging Co. with 3 dredges in the Folsom district (Sacramento County) were the largest operators and produced over three fourths of the total dredge output. Each of the following companies or individuals, also listed in order of output, operated a single dredge: Snelling Gold Dredging Co., Snelling, Merced County; Gold Hill Dredging Co., Folsom City, Sacramento County; La Grange Gold Dredging Co., La Grange, Stanislaus County; Trinity Dredging Co., Lewiston, Trinity County; Lancha Plana Gold Dredging Co. in Amador County near Camanche; Oroville Gold Dredging Co., Oroville, Butte County; Gold Bar Dredging Corporation, Lewiston, Trinity County; Canyon Creek Dredge (J. E. Croudace, trustee), Georgetown, Eldorado County; Cal Oro Dredging Co., Yreka, Siskiyou County; Sierra Gold Dredging Co., Stanfield Hill property, Yuba County; Oro Bell Dredging Co., Loomis, Placer County; M. D. Baker, Igo, Shasta County; Lloyd. B. Onyett Dredging Co., Palermo, Butte County; Allen Placers, Inc., Burson, Calaveras County; and Charles Staheli, Cottonwood, Shasta County. Altogether, 18 companies and individuals operated 30 dredges and handled 59,260,208 cubic yards of gravel with an average recovery of 0.00327 ounce of fine gold per cubic yard. Although there was a slight decrease in 1934 in the quantity of gold produced by dredging, the value of the output increased $1,626,383 (31.5 percent) 3 more companies and 5 more dredges were in operation than in 1933 The increase in price of gold notably extended the areas that may be dredged profitably, and at the close of the year several new dredges were being built and much ground was being prospected to determine its suitability for dredging.

The output from drift placers was 12,992.78 fine ounces of gold (1.8 percent of the State total gold) in 1934 compared with 16,981.08 ounces in 1933, a decrease of 3,988.30 ounces (23.5 percent). The largest producing drift placers, in order of output, were: Calaveras Central, 1 mile northeast of Angels Camp, Calaveras County; Vallecito Western, 3 miles east of Angels Camp, Calaveras County; Lloyd, 3 miles west of San Andreas, Calaveras County; Golden River, near Angels Camp, Calaveras County; Golden Bear, near Alleghany, Sierra County; and Bunker Hill, 14 miles northeast of La Porte, Plumas County. These six mines produced a total of 8,179.90 ounces of gold.

Hydraulic mining yielded 9,281.75 fine ounces of gold (1.3 percent of the State total gold) compared with 4,494.94 ounces in 1933, an increase of 4,786.81 ounces (106.5 percent). It can be carried on successfully in California only in limited areas because of many restrictions as to tailings disposal. The leading producers of gold by hydraulicking were: You Bet mine, 13 miles east of Grass Valley, Nevada County; Red Hill mine, 2 miles west of Junction City, Trinity County; Canyon placers, on Canyon Creek near Dedrick, Trinity County; Paragon mine, 2 miles northeast of Foresthill, Placer County; and Omega mine, 3 miles southeast of Washington, Nevada County. These five mines yielded a total of 5,467.65 ounces of gold.

A total of 34,888 fine ounces of gold (5 percent of the State total) cannot be traced to individual properties but can be traced to the districts or counties from which it came. The major part of this gold was derived by itinerant miners from small-scale placer operations; some was from pocket hunting and formed a part of that purchased by 136 bullion dealers in the State, including banks, merchants, and private refiners licensed by the State mineralogist of California under the Ore Buyer's License Act commonly known as the "High-Grade Bill." Most of the placer gold purchased by licensed bullion buyers came from the following localities: Consumnes River, Eldorado and Amador Counties; Feather River and its tributaries, Butte and Plumas Counties; Big Butte Creek, Butte County; Mokelumne River, Amador and Calaveras Counties; Big Canyon and Webber Creeks, Eldorado County; Bull Creek, Mariposa County; Yuba River and Deer Creek, Nevada County; American River and its North and Middle Forks and Blue Canyon and Indian Creeks, Placer County; Black Hawk, Nelson, Rush, Sloat, Spanish, and Squirrel Creeks, Plumas County; Klamath and Salmon Rivers and their tributaries, Siskiyou County; Sacramento River and its tributaries (Clear, Cottonwood, and Squaw Creeks) and French Gulch, Shasta County; Trinity River and its tributaries, Trinity County; and Stanislaus and Tuolumne Rivers and Woods Creek, Tuolumne County. Some of the gold purchased was recovered from beach sands in Humboldt, Monterey, and Santa Cruz Counties, and small quantities were derived from San Gabriel and San Francisquito Canyons, Los Angeles County.

Silver.—The output of silver from California mines was 844,413 fine ounces valued at $545,883 in 1934 compared with 402,591 ounces valued at $140,907 in 1933, an increase of 110 percent in quantity and 287 percent in value; the average price was 64.6+ cents per ounce in 1934 compared with 35 cents in 1933. Lode mines yielded 821,165 ounces (97 percent) of the total silver in 1934; placers yielded 23,248 ounces, of which dredges recovered 12,386 ounces.

Nevada County with a production of 314,309 ounces, largely from gold ore mined in the Grass Valley-Nevada City district, ranked first in output. San Bernardino County with 228,314 ounces, mostly from gold-silver ore from the Kelly mine in the Randsburg district, ranked second. Kern County with 113,646 ounces, more than half of which came from gold ore from the recently discovered Silver Queen mine at Mojave, ranked third. Inyo and Mono Counties with 40,130 and 31,255 ounces, respectively, ranked fourth and fifth; lead ore from the Estelle and the Santa Rosa mines in the Cerro Gordo district was the principal source of silver in Inyo County, and silver ore from the Silverado mine yielded almost all the silver produced in Mono County. These five counties produced 727,654 ounces (86 percent) of the State total. Of the total lode silver, 542,071 ounces (66 percent) came from gold ore, etc., 180,287 ounces (22 percent) from gold-silver ore, 47,276 ounces (5.8 percent) from silver ore, 49,729 ounces (6 percent) from lead ore, and 1,802 ounces (0.2 percent) from copper and copper-lead ores.

Copper.—The copper output of California was 569,068 pounds valued at $45,525 in 1934 compared with 990,380 pounds valued at $63,384 in 1933, a decrease of 42.5 percent in quantity and 28.2 percent in value; the average price was 8 cents per pound in 1934 compared with 6.4 cents in 1933. Shasta and Nevada Counties, with outputs of 388,473 and 99,272 pounds, respectively, supplied 85.7 percent of the total copper produced in the State in 1934. The Mountain Copper Co., Ltd., made almost the entire output of Shasta County; it shipped cupriferous pyrites from the Hornet mine to manufacturers of sulphuric acid and treated the pyritic residues in its leaching plant at Martinez, Contra Costa County, and also recovered cement copper from water from the Iron Mountain mine and shipped it to the Martinez plant for conversion into bluestone. The copper output of Nevada County was a byproduct from the treatment of cupriferous gold ore; the San Juan mine of the Bradley Mining Co. at North San Juan in the Grass Valley-Nevada City district produced more than half the county total.

Lead.—The output of lead from California mines was 823,168 pounds valued at $30,457 in 1934 compared with 761,156 pounds valued at $28,163 in 1933, an increase of 8 percent in both quantity and value; the average price was 3.7 cents per pound in both years. Inyo, Nevada, and San Bernardino Counties, with outputs of 553,007, 129,869, and 102,672 pounds, respectively, supplied over 95 percent of the State total in 1934. In Inyo County the bulk of the production was from lead ore from the Estelle and Santa Rosa mines in the Cerro Gordo district and the Carbonate mine in the Carbonate district. In Nevada County the lead output was a byproduct from gold ore. In San Bernardino County most of the lead came from lead ore mined in the Ord Mountain and Slate Range districts.

Zinc.—The zinc output of California was 721,719 pounds valued at $31, 034 in 1934 compared with 290,214 pounds valued at $12,189 in 1933, an increase of 149 percent in quantity and 155 percent in value; the average price was 4.3 cents per pound in 1934 compared with 4.2 cents in 1933. In 1934 the entire zinc output of the State came from zinc ore mined in Inyo County.

MINE PRODUCTION BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in California in 1934, by counties, in terms of recovered metals

County	Gold					
	Lode		Placer		Total	
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Alpine	106.60	$3,726			106.60	$3,726
Amador	59,218.36	2,069,682	5,853.88	$204,593	65,072.24	2,274,275
Butte	2,658.27	92,907	12,906.82	451,093	15,565.09	544,000
Calaveras	24,786.69	866,295	11,690.05	408,567	36,476.74	1,274,862
Colusa	13.64	477			13.64	477
Del Norte	28.13	983	202.99	7,095	231.12	8,078
Eldorado	32,938.06	1,151,185	6,567.24	229,525	39,505.30	1,380,710
Fresno	107.68	3,763	580.91	20,303	688.59	24,066
Humboldt			829.13	28,978	829.13	28,978
Imperial	253.16	8,848	32.20	1,125	285.36	9,973
Inyo	7,515.85	262,679	98.13	3,430	7,613.98	266,109
Kern	28,294.19	988,882	943.27	32,967	29,237.46	1,021,849
Kings	19.85	694			19.85	694
Lassen	306.08	10,697	114.21	3,992	420.29	14,689
Los Angeles	772.36	26,994	884.97	30,930	1,657.33	57,924
Madera	200.35	7,002	176.27	6,161	376.62	13,163
Mariposa	13,704.85	478,985	1,100.38	38,458	14,805.23	517,443
Merced			17,130.05	598,695	17,130.05	598,695
Modoc	128.66	4,497	52.26	1,826	180.92	6,323
Mono	1,522.20	53,201	82.72	2,891	1,604.92	56,092
Monterey	8.22	287	6.57	230	14.79	517
Nevada	195,058.73	6,817,303	8,619.40	301,248	203,678.13	7,118,551
Orange			16.37	572	16.37	572
Placer	7,821.28	273,354	7,855.17	274,538	15,676.45	547,892
Plumas	639.43	22,348	3,739.86	130,708	4,379.29	153,056
Riverside	927.46	32,415	271.36	9,484	1,198.82	41,899
Sacramento	48.08	1,680	101,682.06	3,553,788	101,730.14	3,555,468
San Bernardino	7,756.83	271,101	883.91	30,893	8,640.74	301,994
San Diego	551.74	19,283	178.27	6,231	730.01	25,514
San Joaquin			32.43	1,133	32.43	1,133
San Luis Obispo	39.92	1,395	15.77	551	55.69	1,946
Santa Cruz			3.72	130	3.72	130
Shasta	18,201.38	636,138	2,358.94	82,445	20,560.32	718,583
Sierra	26,142.75	913,689	3,258.75	113,893	29,401.50	1,027,582
Siskiyou	6,193.23	216,453	8,925.38	311,942	15,118.61	528,395
Stanislaus	5.79	202	6,837.07	238,956	6,842.86	239,158
Tehama			32.78	1,146	32.78	1,146
Trinity	3,145.63	109,940	13,297.31	464,741	16,442.94	574,681
Tulare	121.55	4,248	24.77	866	146.32	5,114
Tuolumne	5,002.59	174,841	2,701.44	94,415	7,704.03	269,256
Ventura	98.20	3,432	28.69	1,003	126.89	4,435
Yolo			5.05	176	5.05	176
Yuba	701.30	24,510	54,004.28	1,887,450	54,705.58	1,911,960
	445,039.09	15,554,116	274,024.83	9,577,168	719,063.92	25,131,284
Total, 1933	352,199.99	[1] 9,002,232	261,378.86	[1] 6,680,843	613,578.85	[1] 15,683,075

[1] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value $20.67+per ounce).

Mine production of gold, silver, copper, lead, and zinc in California in 1934, by counties, in terms of recovered metals—Continued

County	Silver					
	Lode		Placer		Total	
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Alpine	3,668	$2,371			3,668	$2,371
Amador	15,780	10,201	531	$343	16,311	10,544
Butte	3,864	2,498	1,043	674	4,907	3,172
Calaveras	9,682	6,259	1,179	762	10,861	7,021
Colusa	5	3			5	3
Del Norte	4	3	16	10	20	13
Eldorado	8,074	5,220	1,261	815	9,335	6,035
Fresno	28	18	107	69	135	87
Humboldt			124	80	124	80
Imperial	105	68	5	3	110	71
Inyo	40,106	25,927	24	16	40,130	25,943
Kern	113,434	73,331	212	137	113,646	73,468
Kings	4	3			4	3
Lassen	373	241	57	37	430	278
Los Angeles	622	402	205	133	827	535
Madera	68	44	39	25	107	69
Mariposa	4,792	3,098	179	116	4,971	3,214
Merced			1,625	1,051	1,625	1,051
Modoc	79	51	24	16	103	67
Mono	31,243	20,197	12	8	31,255	20,205
Monterey	1	1			1	1
Nevada	313,222	202,487	1,087	703	314,309	203,190
Orange			2	1	2	1
Placer	9,754	6,306	1,054	681	10,808	6,987
Plumas	648	419	463	299	1,111	718
Riverside	631	408	33	21	664	429
Sacramento	61	39	4,487	2,901	4,548	2,940
San Bernardino	228,138	147,483	176	114	228,314	147,597
San Diego	271	175	18	12	289	187
San Joaquin			3	2	3	2
San Luis Obispo	5	3	3	2	8	5
Santa Cruz			2	1	2	1
Shasta	25,728	16,632	284	184	26,012	16,816
Sierra	6,577	4,252	455	294	7,032	4,546
Siskiyou	1,451	938	1,428	923	2,879	1,861
Stanislaus	15	10	826	534	841	544
Tehama			3	2	3	2
Trinity	793	513	1,744	1,127	2,537	1,640
Tulare	138	89	7	5	145	94
Tuolumne	1,555	1,005	220	142	1,775	1,147
Ventura	8	5	2	1	10	6
Yolo			1	1	1	1
Yuba	238	154	4,307	2,784	4,545	2,938
	821,165	530,854	23,248	15,029	844,413	545,883
Total, 1933	382,131	133,746	20,460	7,161	402,591	140,907

Mine production of gold, silver, copper, lead, and zinc in California in 1934, by counties, in terms of recovered metals—Continued

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Alpine	448	$36	1,564	$58			$6,191
Amador	6,889	551	4,770	176			2,285,546
Butte	1,488	119	110	4			547,295
Calaveras	259	21					1,281,904
Colusa							480
Del Norte							8,091
Eldorado	4,281	342	176	7			1,387,094
Fresno	155	12					24,165
Humboldt							29,058
Imperial							10,044
Inyo	35,849	2,868	553,007	20,461	721,719	$31,034	346,415
Kern	3,511	281	10,929	404			1,096,002
Kings							697
Lassen	177	14					14,981
Los Angeles	495	40	4,026	149			58,648
Madera							13,232
Mariposa	1,021	82					520,739
Merced							599,746
Modoc							6,390
Mono	495	40	7,487	277			76,614
Monterey							518
Nevada	99,272	7,942	129,869	4,805			7,334,488
Orange							573
Placer	338	27					554,906
Plumas	716	57	2,939	109			153,940
Riverside	1,598	128	1,207	45			42,501
Sacramento							3,558,408
San Bernardino	22,893	1,831	102,672	3,799			455,221
San Diego							25,701
San Joaquin							1,135
San Luis Obispo							1,951
Santa Cruz							131
Shasta	388,473	31,078					766,477
Sierra	531	42	2,498	92			1,032,262
Siskiyou			115	4			530,260
Stanislaus							239,702
Tehama							1,148
Trinity	179	14					576,335
Tulare			1,799	67			5,275
Tuolumne							270,403
Ventura							4,441
Yolo							177
Yuba							1,914,898
	569,068	45,525	823,168	30,457	721,719	31,034	25,784,183
Total, 1933	990,380	63,384	761,156	28,163	290,214	12,189	[1] 15,927,718

[1] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Ore treated and gold and silver recovered at gold mills in the Mother Lode counties in California in 1934 [1]

County	Ore treated	Gold and silver recovered in bullion			Concentrates produced [2]	Gold and silver recovered from concentrates			Value of total recovery	
		Gold	Silver	Average value per ton of ore		Gold	Silver	Average value per ton of concentrates	Total	Average value per ton of ore
	Short tons	*Fine ounces*	*Fine ounces*		*Short tons*	*Fine ounces*	*Fine ounces*			
Amador	146,682	40,424.50	8,110	$9.67	2,437	8,439.88	2,598	$121.73	$1,714,733	$11.69
Calaveras	286,072	20,146.77	7,040	2.48	912	3,909.11	2,222	151.38	846,740	2 96
Eldorado	139,159	14,939.98	4,330	3.77	3,833	10,216.03	2,313	93.54	883,496	6.35
Mariposa	56,693	7,381.62	2,131	4.57	594	5,825.63	1,910	344.85	464,207	8.19
Tuolumne	13,256	3,767.62	984	9.98	209	1,039.96	487	175.42	168,976	12.75
	641,862	86,660.49	22,595	4.74	7,985	29,430.61	9,530	129.59	4,078,152	6.35
Total, 1933	290,833	72,419.78	15,531	[3] 6.38	5,218	17,785.16	6,287	[3] 87.54	[3] 2,313,275	[3] 7.95

[1] Old tailings and mill cleanings excluded.
[2] Includes only concentrates recovered from gold ore.
[3] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

MINING INDUSTRY

Mining in California virtually is confined to gold mining, and the higher price of gold in 1934 stimulated greatly the development of both old and new properties. Although considerable time is required to prepare for increasing the yields of operating mines, to rehabilitate old properties, and to bring prospects to the producing stage, the effects o the advance in average price per ounce of gold from $25.56 in 1933 to $34.95 in 1934 were evidenced by increases of 17 and 60 percent, respectively, in the quantity and value of the gold produced in the State and by notable increases in the number of both lode and placer mines operated. The increase in price of gold transformed much vein material too low in grade to be mined profitably heretofore into pay ore and similarly converted large areas of marginal placer gravel into paying ground. At the end of the year several new bucket dredges were being installed, there was conspicuous activity in equipping placers with drag-line dredges, and many lode and placer properties were under option. The few copper mines in the State remained closed. Lead mining was active only where the lead ores carried high values in silver, the average price of which was the highest since 1925.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in California in 1934, with content in terms of recovered metals

Source	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold ore	[1] 2,238,836	441,310.34	542,071	144,963	204,465	
Dry gold-silver ore	58,774	2,522.78	180,287	1,367	677	
Dry silver ore	2,089	73.67	47,276	2,190	7,036	
Copper ore	[2] 53,357	36.31	108	[3] 390,287	941	
Copper-lead ore	11	3.04	1,694	452	2,346	
Lead ore	2,160	1,092.95	49,729	29,809	607,703	
Zinc ore	864					721,719
Total, lode mines	2,356,091	445,039.09	821,165	[3] 569,068	823,168	721,719
Total, placers		274,024.83	23,248			
	2,356,091	719,063.92	844,413	[3] 569,068	823,168	721,719
Total, 1933	1,322,100	613,578.85	402,591	[4] 990,380	761,156	290,214

[1] Includes 38,745 tons of old tailings amalgamated, 285,232 tons of old tailings and 100 tons of mill cleanings cyanided, 2,040 tons of old tailings, 9 tons of slag, and 14 tons of mill cleanings smelted, and 614 tons o old tailings concentrated.

[2] Includes 53,328 tons of pyrites roasted for the manufacture of sulphuric acid—residue leached.

[3] Includes 80,619 pounds of copper from mine water.

[4] Includes 257,537 pounds of copper from copper concentrates produced in 1930 but not marketed until 1933 and 167,036 pounds of copper from mine water.

Value of metals from ore, old tailings, etc., sold or treated in California in 1934, by classes of ore

Class	Ore, old tailings, etc. (short tons)	Gold	Silver	Copper	Lead	Zinc	Total value
Dry gold ore	2,238,836	$15,423,796	$350,430	$11,597	$7,565		$15,793,388
Dry gold-silver ore	58,774	88,171	116,549	109	25		204,854
Dry silver ore	2,089	2,575	30,562	175	260		33,572
Copper ore	53,357	1,269	70	[1] 31,223	35		32,597
Copper-lead ore	11	106	1,095	36	87		1,324
Lead ore	2,160	38,199	32,148	2,385	22,485		95,217
Zinc ore	864					$31,034	31,034
	2,356,091	15,554,116	530,854	[1] 45,525	30,457	31,034	16,191,986
Total, 1933	1,322,100	[2] 9,002,232	133,746	[3] 63,384	28,163	12,189	[2] 9,239,714

[1] Includes value of 80,619 pounds of copper from mine water.
[2] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).
[3] Includes value of 257,537 pounds of copper from copper concentrates produced in 1930 but not marketed until 1933 and 167,036 pounds of copper from mine water.

Ore, old tailings, etc., sold or treated in California in 1934, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Alpine	60	70.10	181	267	887	
Amador	[1] 367,783	59,218.36	15,780	6,889	4,770	
Butte	[2] 12,295	2,658.27	3,864	1,488	110	
Calaveras	[3] 288,229	24,786.69	9,682	259		
Colusa	[4] 56	13.64	5			
Del Norte	179	28.13	4			
Eldorado	[5] 203,671	32,938.06	8,074	4,281	176	
Fresno	344	107.68	28	155		
Imperial	1,261	253.16	105			
Inyo	[6] 21,481	7,101.36	5,072	13,412	40,022	
Kern	[7] 179,382	28,265.19	108,181	2,439	4,336	
Kings	80	19.85	4			
Lassen	328	306.08	373	177		
Los Angeles	1,990	746.16	567	495	1,231	
Madera	906	200.35	68			
Mariposa	[8] 62,244	13,704.85	4,792	1,021		
Modoc	772	128.66	79			
Mono	2,164	1,492.76	2,676	495	7,487	
Monterey	32	8.22	1			
Nevada	[9] 599,141	195,058.73	313,222	99,272	129,869	
Placer	51,797	7,821.28	9,754	338		
Plumas	3,266	639.43	648	716	2,939	
Riverside	3,820	897.75	631	304	1,207	
Sacramento	121	48.08	61			
San Bernardino	[10] 13,521	4,635.72	21,537	11,966	8,818	
San Diego	2,260	551.74	271			
San Luis Obispo	16	39.92	5			
Shasta	[11] 247,879	18,201.38	25,728	279		
Sierra	[12] 56,431	26,142.75	6,577	531	2,498	
Siskiyou	92,827	6,193.23	1,451		115	
Stanislaus	2	5.79	15			
Trinity	7,479	3,145.63	793	179		
Tulare	226	79.25	41			
Tuolumne	[13] 13,886	5,002.59	1,555			
Ventura	315	98.20	8			
Yuba	2,592	701.30	238			
	2,238,836	441,310.34	542,071	144,963	204,465	
Total, 1933	1,261,869	349,431.32	260,505	54,550	134,069	

[1] Includes 5,500 tons of old tailings amalgamated, 206,804 tons of old tailings cyanided, and 2,040 tons of old tailings and 3 tons of slag smelted.
[2] Includes 90 tons of old tailings amalgamated.
[3] Includes 1,170 tons of old tailings amalgamated and 560 tons concentrated.
[4] Old tailings amalgamated.
[5] Includes 5 tons of slag and 14 tons of mill cleanings smelted.
[6] Includes 130 tons of old tailings cyanided and 54 tons concentrated.
[7] Includes 2,394 tons of old tailings amalgamated, 69,172 tons of old tailings cyanided, and 1 ton of slag smelted.
[8] Includes 444 tons of old tailings amalgamated and 5,000 tons cyanided.
[9] Includes 28,791 tons of old tailings amalgamated.
[10] Includes 2,350 tons of old tailings and 100 tons of mill cleanings cyanided.
[11] Includes 1,200 tons of old tailings cyanided.
[12] Includes 300 tons of old tailings amalgamated.
[13] Includes 576 tons of old tailings cyanided.

Ore, old tailings, etc., sold or treated in California in 1934, by counties, with content in terms of recovered metals—Continued

DRY GOLD-SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Alpine	142	36.50	3,487	181	677	
Inyo	244	61.38	2,560			
San Bernardino	58,388	2,424.90	174,240	1,186		
	58,774	2,522.78	180,287	1,367	677	
Total, 1933	19,952	1,321.31	94,700	1,579	1,178	

DRY SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Inyo	68	1.17	3,614	75	97	
Kern	99	11.10	3,161			
Mono	1,714	29.44	28,567			
San Bernardino	208	31.96	11,934	2,115	6,939	
	2,089	73.67	47,276	2,190	7,036	
Total, 1933	22	3.63	1,381			

COPPER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Kern	15	6.60	108	799	941	
Riverside	14	29.71		1,294		
Shasta	[14] 53,328			[15] 388,194		
	53,357	36.31	108	[15] 390,287	941	
Total, 1933	38,176	1,153.95	5,015	[16] 928,039	572	

COPPER-LEAD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Inyo	6	2.44	678	275	1,706	
Kern	5	.60	1,016	177	640	
	11	3.04	1,694	452	2,346	
Total, 1933	8	14.87	233	710	2,006	

LEAD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Inyo	1,526	349.50	28,182	22,087	511,182	
Kern	35	10.70	968	96	5,012	
Los Angeles	9	26.20	55		2,795	
San Bernardino	582	664.25	20,427	7,626	86,915	
Tulare	8	42.30	97		1,799	
	2,160	1,092.95	49,729	29,809	607,703	
Total, 1933	1,257	222.41	19,785	3,803	611,195	

ZINC ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Inyo	864					721,719
	864					721,719
Total, 1933	816	52.50	512	1,699	12,136	290,214

[14] Pyrites roasted for the manufacture of sulphuric acid—residue leached.
[15] Includes 80,619 pounds of copper from mine water.
[16] Includes 257,537 pounds of copper from copper concentrates produced in 1930 but not marketed until 1933 and 167,036 pounds of copper from mine water.

METALLURGIC INDUSTRY

In 1934 dry gold and gold-silver ores, old tailings, etc., yielded 99.7 percent of the gold recovered from lode mines. Of the total lode gold, amalgamation of ore and old tailings yielded 244,720 ounces (55.0 percent); cyanidation of concentrates, 75,136 ounces (16.9 percent); cyanidation of ore, old tailings, and mill cleanings, 53,606 ounces (12.0 percent); smelting of concentrates, 53,108 ounces (11.9 percent); and smelting of ore, old tailings, mill cleanings, and slag, 18,469 ounces (4.2 percent). Of the total lode silver, smelting of concentrates yielded 309,858 ounces (37.7 percent); smelting of ore, old tailings, mill cleanings, and slag, 213,891 ounces (26.0 percent); cyanidation of concentrates, 121,348 ounces (14.8 percent); cyanidation of ore, old tailings, and mill cleanings, 113,987 ounces (13.9 percent); and amalgamation of ore and old tailings, 62,081 ounces (7.6 percent). The large extent to which flotation has displaced table concentration in California is illustrated by the fact that in 1934 flotation concentrates comprised 81 percent of the concentrates cyanided and 90 percent of those smelted.

Details for 1934 of the treatment of ore, etc., produced in the State are shown in the following tables.

Mine production of metals in California in 1934, by methods of recovery

Method of recovery	Material treated (dry weight)	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Ore and old tailings amalgamated	1,445,344	244,720.36	62,081			
Ore, old tailings, and mill cleanings cyanided	636,715	53,605.48	113,987	[1] 1,303		
Concentrates cyanided:						
Flotation	8,692	69,231.45	119,277			
Table and vanner	2,027	5,904.65	2,071			
Ore, old tailings, slag, and mill cleanings smelted	[2] 27,678	18,469.04	213,891	110,356	681,645	721,719
Concentrates smelted:						
Flotation	14,851	47,397.85	297,350	64,682	135,068	
Table and vanner	1,637	5,710.26	12,508	4,533	6,455	
Pyrites roasted for acid—residue leached	[3] 53,328			[4] 388,194		
Total, lode mines		445,039.09	821,165	[4] 569,068	823,168	721,719
Total, placers		274,024.83	23,248			
		719,063.92	844,413	[4] 569,068	823,168	721,719
Total, 1933		613,578.85	402,591	[5] 990,380	761,156	290,214

[1] From cyanide precipitates.
[2] Includes 2,040 tons of old tailings yielding 1,017.80 ounces of gold, 1,502 ounces of silver, and 4,495 pounds of copper; 9 tons of slag yielding 46.40 ounces of gold, 553 ounces of silver, and 77 pounds of copper; and 14 tons of mill cleanings yielding 254.95 ounces of gold and 63 ounces of silver.
[3] Residue leached amounted to 53,270 tons.
[4] Includes 80,619 pounds of copper from mine water.
[5] Includes 257,537 pounds of copper from copper concentrates produced in 1930 but not marketed until 1933 and 167,036 pounds of copper from mine water.

Mine production of metals from gold and silver mills in California in 1934, by counties, in terms of recovered metals [1]

County	Ore, old tailings, etc., treated		Recovered in bullion			
			Amalgamation		Cyanidation	
	Ore	Old tailings, etc.	Gold	Silver	Gold	Silver
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*
Amador	146,682	212,304	40,547.86	8,169	7,928.97	2,197
Butte	11,837	90	517.10	102	958.78	1,000
Calaveras	286,072	1,170	11,930.62	4,161	8,544.00	2,925
Colusa	----------	56	13.64	5	----------	----------
Del Norte	179	----------	28.13	4	----------	----------
Eldorado	139,159	----------	11,449.50	2,434	3,490.48	1,896
Fresno	328	----------	99.28	19	----------	----------
Imperial	1,260	----------	139.81	19	109.05	86
Inyo	2,931	130	1,040.12	2,949	58.41	33
Kern	76,835	71,566	11,423.97	3,433	7,901.06	23,568
Kings	80	----------	19.85	4	----------	----------
Lassen	16	----------	12.09	4	----------	----------
Los Angeles	1,932	----------	641.80	162	3.85	4
Madera	897	----------	192.55	65	----------	----------
Mariposa	56,693	5,444	7,571.92	2,265	118.31	39
Modoc	758	----------	44.18	19	----------	----------
Mono	3,553	----------	835.99	539	29.44	28,567
Monterey	32	----------	8.22	1	----------	----------
Nevada	544,076	28,791	112,764.69	25,907	4,739.88	24,166
Placer	51,582	----------	4,236.69	1,301	2,090.30	3,036
Plumas	3,105	----------	469.70	115	----------	----------
Riverside	3,691	----------	682.19	237	98.00	160
Sacramento	89	----------	27.96	37	----------	----------
San Bernardino	4,798	[1] 2,450	1,493.12	2,447	697.85	1,080
San Diego	2,247	----------	476.74	180	----------	----------
Shasta	246,611	1,200	1,190.33	315	16,633.46	25,152
Sierra	56,004	300	24,144.67	4,643	----------	----------
Siskiyou	92,728	----------	5,601.43	880	----------	----------
Trinity	7,427	----------	2,569.45	509	8.94	18
Tulare	226	----------	79.25	41	----------	----------
Tuolumne	13,256	576	3,767.62	984	143.91	58
Ventura	315	----------	98.20	8	----------	----------
Yuba	2,583	----------	601.69	123	50.79	2
	1,757,982	[1] 324,077	244,720.36	62,081	53,605.48	113,987
Total, 1933	1,073,954	90,728	254,754.73	140,956	30,716.46	46,933

County	Concentrates and recovered metal				
	Concentrates produced	Gold	Silver	Copper [1]	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amador	2,470	8,663.97	2,660	424	345
Butte	77	749.79	2,504	1,400	110
Calaveras	941	3,930.52	2,227	----------	----------
Eldorado	3,833	10,216.03	2,313	4,070	----------
Inyo	30	95.93	99	225	353
Kern	188	638.86	2,084	88	329
Mariposa	597	5,828.73	1,912	1,021	----------
Mono	25	72.23	667	----------	----------
Nevada	11,687	72,227.72	232,356	33,305	73,325
Placer	132	1,123.69	3,909	----------	----------
Sacramento	2	2.22	1	----------	----------
San Diego	13	46.30	70	----------	----------
Shasta	55	212.26	140	195	----------
Sierra	412	1,742.68	1,259	385	2,498
Siskiyou	65	341.90	362	----------	----------
Trinity	151	409.04	181	----------	----------
Tuolumne	209	1,039.96	487	----------	----------
Yuba	4	28.06	24	----------	----------
	20,891	107,369.89	253,255	[1] 41,113	76,960
Total, 1933	7,220	36,143.94	25,268	15,155	24,402

[1] Old tailings cyanided in San Bernardino County yielded also 1,303 pounds of copper contained in cyanide precipitates.

Mine production of metals from concentrating mills in California in 1934, by counties, in terms of recovered metals

County	Ore and old tailings treated	Concentrates and recovered metal					
		Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Alpine	140	10	35.10	3,362	181	568	
Amador	6,501	169	874.12	586	1,629	4,425	
Calaveras	857	8	62.55	69			
Eldorado	64,389	2,694	7,024.79	1,042	211		
Inyo	16,978	486	4,605.83	580	7,240		
Kern	21,034	275	2,501.10	2,893	1,512	4,007	
Nevada	24,947	519	3,594.43	25,866	15,701	55,053	
San Bernardino	58,180	2,155	2,176.40	143,553	1,628	510	
	193,026	6,316	20,874.32	177,951	28,102	64,563	
Total, 1933	112,295	[1] 4,087	22,918.83	90,359	[1] 288,393	88,263	34,470

[1] Includes 606 tons of copper concentrates, yielding 257,537 pounds of copper, produced in 1930 but not marketed until 1933.

Gross metal content of California concentrates produced in 1934, by classes of concentrates

Class of concentrates	Concentrates produced	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold	24,859	123,925.86	257,151	72,286	90,489	
Dry gold-silver	2,086	2,154.86	148,557	1,497	944	
Copper-lead	258	2,116.52	25,401	23,858	57,950	
Lead	4	46.97	97	129	2,195	
	27,207	128,244.21	431,206	97,770	151,578	
Total, 1933	[1] 11,307	59,062.77	115,627	[1] 327,071	118,525	37,073

[1] Includes 606 tons of copper concentrates, containing 265,263 pounds of copper, produced in 1930 but not marketed until 1933.

Mine production of metals from California concentrates in 1934, in terms of recovered metals

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Alpine	10	35.10	3,362	181	568	
Amador	2,639	9,538.09	3,246	2,053	4,770	
Butte	77	749.79	2,504	1,400	110	
Calaveras	949	3,993.07	2,296			
Eldorado	6,527	17,240.82	3,355	4,281		
Inyo	516	4,701.76	679	7,465	353	
Kern	463	3,139.96	4,977	1,600	4,336	
Mariposa	597	5,828.73	1,912	1,021		
Mono	25	72.23	667			
Nevada	12,206	75,822.15	258,222	49,006	128,378	
Placer	132	1,123.69	3,909			
Sacramento	2	2.22	1			
San Bernardino	2,155	2,176.40	143,553	1,628	510	
San Diego	13	46.30	70			
Shasta	55	212.26	140	195		
Sierra	412	1,742.68	1,259	385	2,498	
Siskiyou	65	341.90	362			
Trinity	151	409.04	181			
Tuolumne	209	1,039.96	487			
Yuba	4	28.06	24			
Total	27,207	128,244.21	431,206	69,215	141,523	
1933	[1] 11,307	59,062.77	115,627	[1] 303,548	112,665	34,470

BY CLASSES OF CONCENTRATES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
Dry gold	24,859	123,925.86	257,151	52,378	83,488	
Dry gold-silver	2,086	2,154.86	148,557	1,046	897	
Copper-lead	258	2,116.52	25,401	15,701	55,053	
Lead	4	46.97	97	90	2,085	
	27,207	128,244.21	431,206	69,215	141,523	

[1] Includes 606 tons of copper concentrates, yielding 257,537 pounds of copper, produced in 1930 but not marketed until 1933.

Gross metal content of California crude ore shipped to smelters in 1934, by classes of ore

Class of ore	Ore	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold	21,497	15,648.24	112,938	77,273	69,911	
Dry gold-silver	710	331.20	31,138	335	115	
Dry silver	344	38.15	16,166	3,360	7,326	
Copper	29	36.31	108	3,132	991	
Copper-lead	11	3.04	1,694	675	2,452	
Lead	2,160	1,092.95	49,729	41,393	653,551	
Zinc	864					758,885
Total	25,615	17,149.89	211,773	126,168	734,346	758,885
1933	7,436	6,923.64	78,300	105,476	675,938	319,680

Mine production of metals from California crude ore shipped to smelters in 1934, in terms of recovered metals

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Alpine	62	71.50	306	267	996	
Amador	253	150.74	116	264		
Butte	368	432.60	258	88		
Calaveras	130	319.00	300	259		
Eldorado	104	496.21	325		176	
Fresno	16	8.40	9	155		
Imperial	1	4.30				
Inyo	4,150	1,715.56	36,445	28,384	552,654	721,719
Kern	10,100	5,823.80	81,454	1,911	6,593	
Lassen	312	293.99	369	177		
Los Angeles	67	126.71	456	495	4,026	
Madera	9	7.80	3			
Mariposa	107	185.89	576			
Modoc	14	84.48	60			
Mono	325	584.54	1,470	495	7,487	
Nevada	1,327	1,732.01	4,927	50,266	1,491	
Placer	215	370.60	1,508	338		
Plumas	161	169.73	533	716	2,939	
Riverside	143	147.27	234	1,598	1,207	
Sacramento	32	17.90	23			
San Bernardino	7,271	3,389.46	81,058	19,962	102,162	
San Diego	13	28.70	21			
San Luis Obispo	16	39.92	5			
Shasta	68	165.33	121	84		
Sierra	127	255.40	675	146		
Siskiyou	99	249.90	209		115	
Stanislaus	2	5.79	15			
Trinity	52	158.20	85	179		
Tulare	8	42.30	97		1,799	
Tuolumne	54	51.10	26			
Yuba	9	20.76	89			
	25,615	17,149.89	211,773	105,784	681,645	721,719
Total, 1933	7,436	6,923.64	78,300	96,054	633,871	255,744

BY CLASSES OF ORE

	Ore	Gold	Silver	Copper	Lead	Zinc
Dry gold	21,497	15,648.24	112,938	70,919	63,510	
Dry gold-silver	710	331.20	31,138	321	109	
Dry silver	344	38.15	16,166	2,190	7,036	
Copper	29	36.31	108	2,093	941	
Copper-lead	11	3.04	1,694	452	2,346	
Lead	2,160	1,092.95	49,729	29,809	607,703	
Zinc	864					721,719
	25,615	17,149.89	211,773	105,784	681,645	721,719

REVIEW BY COUNTIES AND DISTRICTS

Mine production of gold, silver, copper, lead, and zinc in California in 1934, by counties and districts, in terms of recovered metals [1]

County and district [1]	Mines producing		Ore, old tailings, etc.	Gold			Silver (lode and placer) [2]	Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total					
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Alpine County: Monitor	3		202	106.60		106.60	3,668	448	1,564		$6,191
Amador County:											
East Belt [3]	20	19	2,658	1,380.19	349.82	1,730.01	962	1,813	4,418		61,394
Lancha Plana		3			4,549.71	4,549.71	384				159,260
Mother Lode [4]	24	40	365,125	57,838.17	954.35	58,792.52	14,965	5,076	352		2,064,892
Butte County:											
Butte Creek	2	5	225	17.45	301.35	318.80	34				11,164
Enterprise		1			178.00	178.00	20				6,234
Forbestown	1		35	72.53		72.53	31				2,555
Magalia	10	15	2,677	482.65	921.44	1,404.09	250				49,235
Merrimac		12			522.62	522.62	52				18,300
Oroville	8	30	849	383.11	10,015.74	10,398.85	937	88			364,053
Palermo		1			342.15	342.15	30				11,977
Stirling City		6			41.92	41.92	2				1,466
Yankee Hill	(5)	4	(5)	(5)	282.75	[6] 282.75	[6] 19				[6] 9,894
Calaveras County:											
Camanche		7			2,369.00	2,369.00	139				82,887
Campo Seco	1	14	59	78.40	478.63	557.03	59				19,506
Copperopolis		6			28.65	28.65	2				1,002
East Belt [3]	22	11	38,924	3,262.78	134.88	3,397.66	2,331	259			120,276
Jenny Lind	(5)	13	(5)	(5)	427.70	[6] 427.70	[6] 19				[6] 14,960
Mother Lode [4]	21	52	242,338	20,306.31	8,251.19	28,557.50	7,688				1,003,055
Colusa County: Wilbur Springs	1		56	13.64		13.64	5				480
Del Norte County:											
Big Flat		1			124.34	124.34	9				4,352
French Hill	(5)	6	(5)	(5)	73.64	[6] 73.64	[6] 5				[6] 2,577
Smith River		2			5.01	5.01	2				176
Eldorado County:											
East Belt [3]	4	10	650	333.32	457.86	791.18	484		176		27,972
Mother Lode [4]	45	78	175,212	29,114.26	6,009.38	35,123.64	6,905	4,281			1,232,377
Fresno County:											
Auberry		5			23.39	23.39	3				819
Copper King	1		40	11.26		11.26					394
Davis Flat	1	3	10	4.32	10.29	14.61	2				512
Friant	3	11	257	64.99	535.29	600.28	116				21,055
Mill Creek	1	3	20	15.84	5.17	21.01	2				735
Sycamore	1	2	16	8.40	6.77	15.17	11	155			549
Temperance Flat	1		1	2.87		2.87	1				101

Humboldt County:											
Gold Bluff	--------	7	--------	--------	38.89	38.89	4	--------	--------	--------	1,362
Orleans	--------	12	--------	--------	756.33	756.33	115	--------	--------	--------	26,508
Weitchpec	--------	7	--------	--------	33.91	33.91	5	--------	--------	--------	1,188
Imperial County:											
Cargo Muchacho	4	5	1,261	253.16	16.25	269.41	108	--------	--------	--------	9,486
Mesquite	--------	3	--------	--------	5.93	5.93	--------	--------	--------	--------	207
Picacho	--------	3	--------	--------	10.02	10.02	2	--------	--------	--------	351
Inyo County:											
Cerro Gordo	3	--------	2,065	151.26	--------	151.26	24,048	20,679	405,992	721,719	68,543
Chloride Cliff	9	--------	235	192.16	--------	192.16	3,825	175	6,578	--------	9,446
Coso	4	1	280	158.44	18.72	177.16	70	--------	--------	--------	6,237
Darwin	4	5	289	100.23	8.05	108.28	2,592	--------	--------	--------	5,460
Echo	2	--------	22	40.80	--------	40.80	549	100	2,195	--------	1,870
Fish Springs	4	--------	814	513.72	--------	513.72	1,209	1,871	28,839	--------	19,954
Lone Pine	4	2	368	218.06	4.06	222.12	920	1,079	12,164	--------	8,894
Modoc	5	1	219	75.31	7.12	82.43	38	--------	--------	--------	2,906
South Park	10	4	1,406	458.08	7.87	465.95	1,685	2,334	10,234	--------	17,940
Union	4	1	689	519.39	52.31	571.70	1,512	1,881	7,391	--------	21,381
White Mountain	6	--------	604	469.77	--------	469.77	918	344	2,212	--------	17,121
Kern County:											
Agua Caliente	6	8	570	247.92	21.40	269.32	101	--------	--------	--------	9,478
Black Bob	3	7	245	70.63	15.99	86.62	2,217	--------	--------	--------	4,460
China Grade	2	--------	25	7.39	--------	7.39	31	--------	--------	--------	278
Clear Creek	2	9	32	14.31	30.52	44.83	10	--------	--------	--------	1,573
Cove	8	--------	20,325	2,108.45	--------	2,108.45	2,977	178	2,763	--------	75,731
Goler	--------	14	--------	--------	176.41	176.41	36	--------	--------	--------	6,189
Greenhorn Mountain	10	7	472	197.37	23.23	220.60	1,952	--------	329	--------	8,984
Long Tom	4	--------	268	92.00	--------	92.00	33	--------	--------	--------	3,236
Mojave	27	7	22,771	11,731.61	12.74	11,744.35	98,608	2,243	2,251	--------	474,474
Pioneer	5	10	735	198.33	68.89	267.22	138	--------	--------	--------	9,428
Piute	2	--------	85	56.25	--------	56.25	137	107	--------	--------	2,064
Rademacher	5	6	652	194.60	18.76	213.36	77	--------	--------	--------	7,507
Randsburg [7]	44	41	133,176	13,312.02	524.94	13,836.96	7,279	983	5,586	--------	488,594
Woody	4	7	180	63.31	50.39	113.70	50	--------	--------	--------	4,006
Kings County: Hanford	2	--------	80	19.85	--------	19.85	4	--------	--------	--------	697
Lassen County: Hayden Hill	3	1	328	306.08	114.21	420.29	430	177	--------	--------	14,981
Los Angeles County:											
Azusa	1	9	42	14.90	33.56	48.46	8	--------	--------	--------	1,699
Cedar	2	9	352	353.83	25.19	379.02	190	--------	2,795	--------	13,473
Pacoima	1	--------	800	96.54	--------	96.54	29	--------	--------	--------	3,393
San Gabriel	3	21	514	82.72	801.58	884.30	218	--------	--------	--------	31,047
Saugus	1	5	36	8.69	24.64	33.33	1	--------	--------	--------	1,166
Valyermo	1	--------	255	215.68	--------	215.68	381	495	1,231	--------	7,870

[1] Only those districts shown separately for which Bureau of Mines is at liberty to publish figures; other producing districts listed in footnote 11 and output included under "Undistributed." Purchases by bullion buyers and production by itinerant miners included in district totals with production by regular producers.

[2] Of the 844,413 ounces of silver produced in 1934, 821,165 ounces were from lode mines and 23,248 ounces from placers.

[3] East Belt district lies in Amador, Calaveras, Eldorado, Mariposa, and Tuolumne Counties.

[4] Mother Lode district lies in Amador, Calaveras, Eldorado, Mariposa, and Tuolumne Counties.

[5] Included under "Undistributed."

[6] Exclusive of lode output, which is included under "Undistributed."

[7] Randsburg district lies in Kern and San Bernardino Counties.

Mine production of gold, silver, copper, lead, and zinc in California in 1934, by counties and districts, in terms of recovered metals—Continued

County and district	Mines producing		Ore, old tailings, etc.	Gold			Silver (lode and placer)	Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total					
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Madera County:											
Coarse Gold	3	5	122	37.15	12.37	49.52	14				$1,740
Daulton	(5)	8	(5)	(5)	14.28	[6] 14.28	[6] 5				[6] 502
Hildreth	2	5	248	46.38	13.21	59.59	30				2,102
Potter Ridge	3	10	436	106.08	136.41	242.49	57				8,512
Mariposa County:											
Colorado	3	7	1,234	331.23	83.29	414.52	74				14,535
Hite Cove	2		1,678	360.66		360.66	112				12,677
Hunter Valley	9	10	6,854	1,403.04	183.42	1,586.46	388				55,698
Mother Lode [4]	26	47	40,855	8,474.01	678.49	9,152.50	3,789	1,021			322,411
Quartzburg	7	7	828	157.10	22.86	179.96	97				6,353
White Rock		1			22.18	22.18	1				776
Whitlock	4	16	10,795	2,978.81	110.14	3,088.95	510				108,289
Merced County: Snelling		17			17,130.05	17,130.05	1,625				599,746
Modoc County:											
High Grade	(5)		(5)	(5)	38.78	[6] 38.78	[6] 23				[6] 1,370
Winters	2	1	21	74.44	13.48	87.92	54				3,108
Mono County:											
Blind Springs	1		2	5.72		5.72	3				202
Bodie	5		1,495	963.29		963.29	1,970	201	5,129		35,147
Chidago [8]	3		612	422.87		422.87	655	294	2,358		15,313
Homer	1	1	55	100.88	32.68	133.56	59				4,706
Patterson	1	1	1,714	29.44	50.04	79.48	28,568				21,246
Monterey County: Los Burros	1	3	32	8.22	6.57	14.79	1				518
Nevada County:											
French Corral	2	14	107	40.86	237.64	278.50	41				9,761
Grass Valley-Nevada City	31	50	558,690	187,875.91	4,942.64	192,818.55	265,392	93,565	129,316		6,922,845
Truckee	2		6,905	68.00		68.00	56				2,413
Washington	7	37	33,305	6,996.35	1,568.06	8,564.41	48,636	5,707	553		331,244
You Bet	3	14	134	77.61	1,871.06	1,948.67	184				68,225
Orange County: Lucas Canyon		4			16.37	16.37	2				573
Placer County:											
Auburn	4	8	1,288	424.58	750.27	1,174.85	286				41,246
Butcher Ranch	3		105	30.36		30.36	3				1,063
Colfax	2	7	142	16.83	723.65	740.48	85				25,935
Dutch Flat	3	12	6,340	692.21	604.85	1,297.06	217				45,472
Forest Hill	5	19	648	200.45	1,450.46	1,650.91	270				57,874
Gold Run		9			600.13	600.13	77				21,025
Iowa Hill	2	9	1,415	607.05	1,031.43	1,638.48	1,567				58,278
Last Chance	2	16	848	534.65	1,202.77	1,737.42	178				60,838
Michigan Bluff	1	3	2,167	328.88	649.04	977.92	187				34,299
Miners Ravine		8			34.15	34.15	2				1,195

Ophir	4	9	10,549	2,854.37	803.25	3,657.62	4,831				130,957
Tahoe	2	3	196	111.41	5.17	116.58	126	338			4,182
Plumas County:											
Butte Valley	1	16	32	7.60	318.60	326.20	40				11,427
Crescent Mills	6	33	2,774	394.40	460.01	854.41	163				29,967
Genesee	2	16	9	4.90	158.19	163.09	16				5,710
Johnsville	2	10	167	51.04	455.35	506.39	113				17,771
La Porte		17			1,143.95	1,143.95	114		2,939		40,164
Lights Canyon	1	3	114	148.93	44.44	193.37	523	716			7,153
North Fork Feather River		5			192.66	192.66	23				6,748
Quincy	2	11	94	14.06	966.66	980.72	115				34,350
Sawpit Flat	1		76	18.50		18.50	4				650
Riverside County:											
Arica	1	4	29	26.09	14.86	40.95	17	86			1,449
Bendigo	6		268	197.61		197.61	169	1,294			7,119
Chuckawalla	5	5	227	108.89	197.49	306.38	242	218	1,207		10,926
Eagle Mountain	1	3	8	3.00	25.55	28.55	3				1,000
Monte Negro	1		99	23.91		23.91	5				839
Pinacate	4		1,522	122.26		122.26	51				4,306
Pinon	7	3	1,040	308.50	33.46	341.96	99				12,016
San Jacinto	1		504	125.64		125.64	69				4,436
Sacramento County: Folsom	3	24	121	48.08	101,682.06	101,730.14	4,548				3,558,408
San Bernardino County:											
Atolia		1			31.41	31.41	11				1,105
Barstow	2		188	72.35		72.35	152				2,627
Buckeye	4		1,994	637.14		637.14	593	965			22,728
Calico	2		116	104.78		104.78	1,673	252	9,278		5,107
Coolgardie	1	1	11	17.55	7.24	24.79	230		10,590		1,407
Dale	7		2,253	287.41		287.41	520	1,303			10,485
Dry Lake	1		125	78.93		78.93	80				2,811
Gold Stone	1		42	18.00		18.00	131	1,144			806
Halloran	2		115	57.57		57.57	328				2,224
Hart	1		716	179.19		179.19	51				6,296
Hikorum	2		40	12.84		12.84	9	554			499
Holcomb	1	10	24	6.13	72.62	78.75	5				2,755
Iron Wood [9]	1		73	39.94		39.94	31	115			1,425
Ivanpah	6		1,547	901.88		901.88	3,227	6,163	7,658		34,383
Kelso	9		1,131	578.51		578.51	1,570	458			21,271
Lava Bed	2		100	41.10		41.10	11				1,443
Monumental	1		134	24.37		24.37	8,858	1,981	6,939		6,993
Morrow		1			10.94	10.94	1				383
Ord Mountain	5	1	279	212.45	149.83	362.28	2,376	1,264	30,252		15,418
Oro Grande	4	6	721	349.95	8.53	358.48	722	163	6,061		13,233
Paradise	1		260	65.17		65.17	5				2,281
Providence	2		26	16.89		16.89	795	82	434		1,127
Randsburg [7]	8	8	59,151	3,021.34	327.71	3,349.05	187,557	1,186			238,393

[4] Mother Lode district lies in Amador, Calaveras, Eldorado, Mariposa, and Tuolumne Counties.
[5] Included under "Undistributed."
[6] Exclusive of lode output, which is included under "Undistributed."
[7] Randsburg district lies in Kern and San Bernardino Counties.
[8] Chidago district lies in Inyo and Mono Counties.
[9] Iron Wood district lies in Riverside and San Bernardino Counties.

Mine production of gold, silver, copper, lead, and zinc in California in 1934, by counties and districts, in terms of recovered metals—Continued

County and district	Mines producing		Ore, old tailings, etc.	Gold			Silver (lode and placer)	Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total					
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
San Bernardino County—Continued.											
Shadow Mountain	1		1,800	0.70		0.70	14		473		$51
Silver Mountain	1		64	30.94		30.94	90				1,139
Slate Range	9	6	1,027	663.98	257.23	921.21	18,205	6,972	30,987		45,670
Twentynine Palms	5	4	413	265.50	10.64	276.14	148	291			9,770
Washington	1		50	6.06		6.06	2				213
Whipple Mountain	6	3	119	58.15	7.76	65.91	917				2,897
San Diego County:											
El Cajon	2	1	96	23.63	11.73	35.36	12				1,244
Julian	6	9	2,164	528.11	166.54	694.65	277				24,457
San Joaquin County:											
Bellota		1			10.42	10.42	1				365
Clements		4			22.01	22.01	2				770
San Luis Obispo County:											
Cambria	1		16	39.92		39.92	5				1,398
La Panza		3			15.77	15.77	3				553
Santa Cruz County: Santa Cruz		2			3.72	3.72	2				131
Shasta County:											
Centerville	2	13	1,542	309.73	287.45	597.18	178				20,986
Clear Creek		1			114.66	114.66	12				4,015
Cottonwood Creek		7			252.02	252.02	20				8,821
Dog Creek		1			3.53	3.53					123
Flat Creek	1		240	59.88		59.88	14				2,102
French Gulch	7	8	1,554	877.24	456.18	1,333.42	270				46,778
Igo		2			216.61	216.61	26				7,588
Muletown	13	13	676	343.38	295.74	639.12	222	279			22,503
Shasta	3	13	53	43.09	493.44	536.53	84				18,806
South Fork	(5)	4	(5)	(5)	13.59	[6] 13.59	[6] 2				[6] 476
Whiskeytown	1	(10)	5	14.36	225.72	240.08	39				8,416
Sierra County:											
Alleghany	11	48	53,883	25,114.08	1,895.08	27,009.16	6,447	441	413		948,188
American Hill	1		22	25.91		25.91	3				908
Downieville	10	29	848	286.39	720.22	1,006.61	189				35,303
Indian Hill		7			157.00	157.00	13				5,495
Pike	1	9	346	279.45	71.77	351.22	205	90	2,085		12,492
Poker Flat		3			11.97	11.97	1				419
Port Wine		6			62.76	62.76	6				2,197
Sierra City	6	26	1,332	436.92	327.46	764.38	166				26,822
Slate Creek		1			12.49	12.49	2				438
Siskiyou County:											
Elliott Creek	5	7	106	68.90	138.21	207.11	44				7,266
Klamath River	4	36	210	139.61	2,099.40	2,239.01	374				78,495

North Central	15	36	1,766	852.46	4,128.08	4,980.54	888		115		174,648
Salmon River	7	33	88,090	4,352.26	2,309.59	6,661.85	827				233,367
Scott River	8	18	2,655	780.00	250.10	1,030.10	746				36,484
Stanislaus County:											
Knights Ferry	1	11	2	5.79	77.16	82.95	25				2,915
La Grange		6			6,711.85	6,711.85	812				235,104
Oakdale		7			48.06	48.06	4				1,683
Tehama County: Los Molinos					32.78	32.78	3				1,148
Trinity County:		(10)									
Big Bar	1	8	16	23.60	565.63	589.23	64	179			20,649
Coffee Creek	6	12	619	234.20	131.86	366.06	107				12,863
Hay Fork	(5)	7	(5)	(5)	200.83	[6] 200.83	[6] 35				[6] 7,042
Helena	(5)	5	(5)	(5)	17.53	[6] 17.53	[6] 2				[6] 614
Junction City	3	10	142	106.05	2,398.14	2,504.19	311				87,722
Lewiston	9	20	5,769	1,920.44	5,199.58	7,120.02	1,159				249,594
New River	3	22	168	48.86	3,226.21	3,275.07	374				114,706
Salyer		8			32.79	32.79	133				1,232
Trinity Center	1	9	19	50.77	101.83	152.60	20				5,346
Weaverville		19			1,422.91	1,422.91	133				49,817
Tulare County:											
Deer Creek	1		20	6.10		6.10	2				214
White River	(5)	3	(5)	(5)	24.77	[6] 24.77	[6] 7				[6] 871
Tuolumne County:											
Columbia	24	38	3,022	1,337.08	1,199.86	2,536.94	438				88,949
East Belt [3]	17	15	8,106	2,607.97	1,075.72	3,683.69	962				129,367
Mother Lode [4]	18	29	2,758	1,057.54	425.86	1,483.40	375				52,087
Ventura County: Piru	3	4	315	98.20	28.69	126.89	10				4,441
Yolo County: Woodland		1			5.05	5.05	1				177
Yuba County:											
Brownsville	2	4	1,607	415.00	67.72	482.72	71				16,917
Camptonville	1	11	1	2.50	163.07	165.57	33				5,808
Dobbins	3	11	436	87.63	2,037.76	2,125.39	214				74,420
Honcut Creek	2	8	241	92.41	226.74	319.15	62				11,194
Smartsville	2	22	164	62.14	1,939.77	2,001.91	332				70,182
Strawberry Valley	3	11	143	41.62	321.65	363.27	38				12,721
Yuba River		16			49,247.57	49,247.57	3,795				1,723,656
Undistributed [11]	22	2	387,967	30,514.85	400.85	30,915.70	37,366	396,980	79,311		1,139,353
Total California, 1934	867	1,784	2,356,091	445,039.09	274,024.83	719,063.92	[2] 844,413	569,068	823,168	721,719	25,784,183
1933	797	993	1,322,100	352,199.99	261,378.86	613,578.85	402,591	990,380	761,156	290,214	[12] 15,927,718

[2] Of the 844,413 ounces of silver produced in 1934, 821,165 ounces were from lode mines and 23,248 ounces from placers.
[3] East Belt district lies in Amador, Calaveras, Eldorado, Mariposa, and Tuolumne Counties.
[4] Mother Lode district lies in Amador, Calaveras, Eldorado, Mariposa, and Tuolumne Counties.
[5] Included under "Undistributed."
[6] Exclusive of lode output, which is included under "Undistributed."
[10] No information as to number of producers; placer output made by itinerant miners.
[11] Includes following districts: Cherokee (all placer) and Yankee Hill (lode), Butte County; Jenny Lind (lode), Calaveras County; French Hill (lode), Del Norte County; Rescue (lode and placer), Eldorado County; Carbonate (all lode) and Chidago (all lode), Inyo County; Daulton (lode), Madera County; High Grade (lode), Modoc County; Dairy Farm (all lode), Placer County; Iron Wood (all lode), Riverside County; Black Hawk (all lode), San Bernardino County; Iron Mountain (all lode) and South Fork (lode), Shasta County; Hay Fork (lode) and Helena (lode), Trinity County; and White River (lode), Tulare County.
[12] Change in value from chapter on California in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

ALPINE COUNTY

The metal output of Alpine County in 1934 came from three mines in the Monitor district and comprised 107 ounces of gold, 3,668 ounces of silver, 448 pounds of copper, and 1,564 pounds of lead, valued in all at $6,191, compared with an output valued at $2,807 in 1933. The Lost Cabin mine near Gardnerville made the largest output of gold in 1934 and the Colorado Hill mine at Markleeville produced most of the silver.

AMADOR COUNTY

Amador County produced 65,072 ounces of gold, 16,311 ounces of silver, 6,889 pounds of copper, and 4,770 pounds of lead in 1934, valued in all at $2,285,546, an increase of 17 percent over $1,953,754 in 1933. Amador ranked third among the counties in total value of output in 1934.

East Belt district.—The principal lode producers in the East Belt district of Amador County in 1934 were the Pioneer mine near Pine Grove and the Petersen mine at Jackson. The Santa Clara and Bordeman drift mines were the chief placer producers.

Lancha Plana district.—Placering was the only mining activity in the Lancha Plana district in 1934. The Lancha Plana Gold Dredging Co. near Camanche operated its 6-cubic foot dredge throughout the year and handled 922,845 cubic yards of gravel with a total recovery of 4,316 ounces of gold and 359 ounces of silver. Hydraulicking at the Buena Vista mine yielded the next largest output of gold.

Mother Lode district.—The leading mines in the Mother Lode district of Amador County in 1934, in order of output, were The Argonaut Mining Co., Ltd., at Jackson, the Kennedy Mining & Milling Co. at Martell, and the Central Eureka Mining Co. at Sutter Creek. These three mines operated only three quarters of the year, as they were shut down October 1 on account of a miners' strike and remained closed the rest of the year. They produced a total of 44,959 ounces of gold and 9,827 ounces of silver. The Argonaut mine, developed by an inclined shaft 6,000 feet deep, is the deepest mine in the State; its 300-ton 60-stamp mill is equipped with 36 vanners, the concentrates from which were shipped to the plant of the Amador Metals Reduction Co. at Jackson for cyanidation. The Kennedy mine is developed by a vertical shaft 4,650 feet deep and an inclined shaft to the 5,250-foot level; 30 stamps of its 100-stamp mill were operated in 1934. After amalgamation the ore was concentrated by flotation and the concentrate was shipped to the Selby smelter. The Amador Metals Reduction Co., operating a custom mill, and the Central Tailings Co. ran their cyanide plants throughout the year and made important contributions to the gold output of the county.

BUTTE COUNTY

The metal output of Butte County in 1934 comprised 15,565 ounces of gold, 4,907 ounces of silver, 1,488 pounds of copper, and 110 pounds of lead, with a total value of $547,295, an increase of 84 percent over $297,202 in 1933.

Butte Creek district.—Nearly the entire yield of the Butte Creek district in 1934 came from placer mines; the Butte Creek and Kelly Hill drift mines were the chief producers.

Cherokee district.—The New Era drift mine made the largest output of gold in the Cherokee district in 1934; 14,623 cubic yards of gravel were washed.

Enterprise district.—The Golden Hope placer mine on the South Fork of Feather River produced 178 ounces of gold and 20 ounces of silver in 1934 with drag-line equipment.

Forbestown district.—The Liberty Bell mine at Forbestown shipped 1 car of ore in 1934 to the Midvale (Utah) smelter.

Magalia district.—A prospect 15 miles east of Chico was the largest producer of lode gold in the Magalia district in 1934, followed by the Springer mine at De Sabla. The chief placer producers were the Cohan-Gooday, Bennett, and Cory mines. The Mammoth channel at the Cohan-Gooday mine was cut by a 3,400-foot tunnel from the West Branch of Feather River, but the bedrock was found to be scoured badly and the gravel extracted was reported not to contain more than 0.035 ounce of gold per cubic yard.

Merrimac district.—Mining activities in the Merrimac district in 1934 were confined to placer mines. The leading producers were the Bidwell Bar and Walker Plains properties.

Oroville district.—The largest production of gold and silver in Butte County in 1934 was made in the Oroville district, and most of it came from placers. The largest lode producers were the Haines mine 13 miles northeast of Oroville, the R. W. Schumacher property, and the Christmas Gift (Phoenix) mine 15 miles southeast of Oroville. The chief placer operations were those of the Oroville Gold Dredging Co., which operated its gold dredge 9 miles south of Oroville and handled 1,160,150 cubic yards with its 7½-cubic foot electric dredge, and the Wyandotte Creek mine where approximately 500,000 cubic yards were handled with a drag-line dredge; these two mines were the largest gold producers in Butte County.

Palermo district.—The Lloyd B. Onyett Dredging Co. at Palermo handled approximately 36,000 cubic yards of gravel in 1934 with its gasoline-powered drag-line dredge and produced 122 ounces of gold and 10 ounces of silver. The rest of the district output was recovered by itinerant miners.

Stirling City district.—Placer mining in the Stirling City district in 1934 yielded nominal quantities of gold and silver.

Yankee Hill district.—The Surcease mine in the Yankee Hill district 22 miles northeast of Oroville operated 11 months in 1934. The installation of a larger compressor and improvements in the 50-ton concentration and cyanidation plant necessitated shutting down for about a month. This property was the outstanding producer of lode gold in Butte County.

CALAVERAS COUNTY

Calaveras County produced 36,477 ounces of gold, 10,861 ounces of silver, and 259 pounds of copper in 1934, valued in all at $1,281,904, an increase of 188 percent over $445,271 in 1933. Calaveras ranked sixth among the counties in total value of output in 1934.

Camanche district.—Most of the output in the Camanche district in 1934 was made by Gold-Gravel Products, Inc., from its placer property adjoining the town of Wallace on the east. At this mine the gravel was excavated with a power shovel and treated in a stationary washing plant which handled 459,841 cubic yards during the year.

Campo Seco district.—The Spring Valley Mining Co. 2 miles east of Valley Springs handled approximately 18,000 cubic yards of gravel in 1934 with a steam shovel and was the outstanding producer of gold in the Campo Seco district.

Copperopolis district.—Small placer properties in the Copperopolis district yielded a few ounces of gold and silver in 1934.

East Belt district.—The Boston mine at Mokelumne Hill was the leading producer in 1934 in the East Belt district of Calaveras County, and a total of 36,372 tons of ore was treated in its 150-ton flotation mill. The ore after being crushed by primary and secondary crushers was ground in a ball mill and floated in air-lift flotation cells; the concentrate was pumped from thickener tanks to an Oliver filter and after drying was trucked to the cyanide plant of the Amador Metals Reduction Co. at Jackson. The Golden Eagle mine at Westpoint, the Oro y Plata at Murphy, and the Carlton mine at Westpoint were the next largest lode producers in the district, but their combined output was relatively unimportant. There were small placer operations along Angels, Coyote, Five Mile, and Six Mile Creeks and the Stanislaus River.

Jenny Lind district.—Two lode mines were in operation in 1934 in the Jenny Lind district. The Royal mine, 9 miles east of Milton, was operated far below its normal capacity, its mill running about 12 days each month and only 20 of its 120 stamps being used in treating 6,886 tons of ore; the mill is equipped for concentration by flotation and vanners. The largest placer producer was the South Gulch mine, 3 miles south of Jenny Lind, which operated a 1¼-cubic yard drag line and produced 336 ounces of gold and 14 ounces of silver.

Mother Lode district.—As the result of one of the largest construction and rehabilitation programs of 1934 the Carson Hill mine at Melones in the Mother Lode district was the outstanding gold producer in Calaveras County and the fourth largest lode-gold producer in the State. Underground development at this mine consists of a 4,350-foot vertical shaft and about 15 miles of drifts and crosscuts, of which more than 1 mile was driven in 1934. Mill capacity was increased to 700 tons a day, and the concentration and cyanidation plants were operated steadily throughout the year. During unwatering of the mine much low-grade surface ore derived by stripping with a power shovel and by mining in several of the old glory holes was milled, but at the end of the year the mill feed consisted entirely of ore from underground. Diamond drilling in the footwall on the 3,000-foot level disclosed important ore bodies. When this report was written (May 1935) a high-speed gyratory crusher had been installed and mill capacity raised thereby to approximately 1,000 tons a day. A total of 222,608 tons of ore was treated in 1934. Ore from the 30-stamp mill was ground in 3 Hardinge mills and after amalgamation was concentrated on 12 tables. The concentrates were ground in a Hardinge mill, the discharge from which was tabled, and the concentrates (containing about 80 ounces of gold to the ton) were treated in an amalgam barrel. All other mill products were cyanided. Sands and slimes were treated separately. The Easy Bird mine of the Lucky Joe Gold Mining Co., 6 miles southeast of Jackson, was the second largest lode-gold producer in the district; concentrates from its flotation mill were shipped to the cyanide plant of the Amador Metals Reduction Co. at Jackson. Other principal producing lode mines were the Osborn at Altaville and the Dunton at Glencoe. The Russell Gold Mining Co. developed its property 1 mile east of Angels Camp and installed a 30-ton amalgamation and concentration plant. The outstanding placer operations in the district were at the Calaveras Central (1 mile northeast of Angels Camp), the Vallecito Western (3 miles east of Angels Camp), and the Lloyd (3 miles west of San Andreas) drift mines. At the Vallecito Western mine 14,143 tons of gravel yielded 2,729 ounces of gold and 315 ounces of silver, and at the Lloyd mine approximately 12,000 tons of gravel yielded 802 ounces of gold and 124 ounces of silver. Among the more important of the small placer operators were the Golden River drift mine near Mokelumne Hill, the Rough Diamond surface placer in Chili Gulch, and the Boundary Cone drift mine in Old Woman's Gulch.

COLUSA COUNTY

The only producer in Colusa County in 1934 was the Gibson property, 25 miles west of Williams in the Wilbur Springs district; a few ounces of gold and silver were recovered from 56 tons of old tailings treated in the 10-ton mill on the property.

DEL NORTE COUNTY

The metal output of Del Norte County in 1934 was 231 ounces of gold and 20 ounces of silver, valued together at $8,091. The only sizable placer mine was the Big Cut on Hurdy Gurdy Creek in the Big Flat district near Crescent City, which yielded 124 ounces of gold and 9 ounces of silver. In the French Hill district the Bee lode mine on the Illinois River treated 179 tons of ore by amalgamation and concentration in its 25-ton mill. The rest of the county output was from small placer operations in the French Hill and Smith River districts.

ELDORADO COUNTY

Eldorado County produced 39,505 ounces of gold, 9,335 ounces of silver, 4,281 pounds of copper, and 176 pounds of lead in 1934, valued in all at $1,387,094, an increase of 156 percent over $542,577 in 1933. Eldorado ranked fifth among the counties in total value of output in 1934.

East Belt district.—The largest lode producers in the East Belt district of Eldorado County in 1934 were the Middle End and Humbug mines at Grizzly Flats. The Cooley drift mine at Volcanoville was the only sizable producer of placer gold; 1,480 tons of gravel from this property yielded 137 ounces of gold and 18 ounces of silver.

Mother Lode district.—The Montezuma mine, 7 miles south of El Dorado, was the largest lode producer in Eldorado County in 1934. At this mine the flotation mill was enlarged to a capacity of 240 tons, and 61,107 tons of ore were treated. The ore was crushed to minus 2-inch size and ground in two Marcy mills to 65-mesh. Free gold was recovered by hydraulic traps between the ball mills and classifiers, the overflow from which passed to flotation cells through launders lined with corduroy. Concentrates were shipped to the Garfield (Utah) and Selby (Calif.) smelters. The mine is developed by an inclined shaft 1,500 feet deep and 7,646 feet of drifts and raises. The second largest lode producer in the county was the Alpine mine of the

Beebe Gold Mining Co. at Georgetown, and approximately 64,300 tons of ore were treated in the 200-ton flotation mill at this property. The ore is ground to 60-mesh in a Hadsell mill and concentrated by Kraut flotation machines; the concentrates are ground to 300-mesh before they are cyanided in a 20-ton plant. The Sliger mine of the Middle Fork Gold Mining Co., 8 miles east of Auburn, was the third largest producer of lode gold in the county; 23,203 tons of ore were treated, and the concentrates were shipped to the Selby smelter. The mine is equipped with a 100-ton flotation mill. Primary crushing is effected by a jaw crusher and a Symons cone crusher and secondary crushing by a Hardinge ball mill. Grinding is done in an Allis-Chalmers and a Hardinge ball mill, the latter in closed circuit with a Dorr classifier from which the discharge goes to a Kraut flotation plant with 4 primary, 2 rougher, and 2 cleaner cells. The Black Oak mine, 20 miles east of Auburn, was the fourth largest producer of lode gold in the county; it is equipped with an 8-stamp mill which treated 1,580 tons of ore during the year. The more important small lode producers were the Kelsey mine, 4½ miles north of Placerville, where a 100-ton flotation mill treated 8,443 tons of ore during the year; the Crystal mine with an output of 1,736 tons of ore; and the Slate Mountain mine, 20 miles northeast of Placerville, where 1,313 tons of ore were treated in its 10-stamp mill and 1,000 feet of development work were done. The largest producer of placer gold in the county was the Canyon Creek dredge on the Gold Bug, Hickman, and Blue Rock claims near Georgetown; it is equipped with thirty-five 3-cubic foot buckets and handled 255,867 cubic yards of gravel during the year.

Rescue district.—The Gold Reserve mine, 4 miles north of Shingle Springs, was the only lode mine operating in the Rescue district in 1934; approximately 27,800 tons of ore were treated. The property is equipped with a 100-ton cyanide plant, and the ore is ground in a mercuric cyanide solution by a system known as the "Vandercook mercuric cyanide process."

FRESNO COUNTY

The metal output of Fresno County in 1934 was 689 ounces of gold, 135 ounces of silver, and 155 pounds of copper, valued in all at $24,165, compared with an output valued at $19,507 in 1933. Over 85 percent of the total value in 1934 came from the Friant district where the Grant Service Rock placer, the largest producer, yielded 233 ounces of gold and 39 ounces of silver from approximately 81,000 cubic yards of bench gravel. The gravel was mined by a drag-line excavator operated by steam and was washed and sized for commercial use.

HUMBOLDT COUNTY

The entire production in Humboldt County in both 1934 and 1933 was derived from placers; it totaled 829 ounces of gold and 124 ounces of silver in 1934, valued together at $29,058, compared with $5,913 in gold and silver in 1933. Beach sands in the Gold Bluff district yielded 39 ounces of gold and 4 ounces of silver. The Orleans district yielded 756 ounces of gold and 115 ounces of silver. The outstanding producer was the Pearch mine near Orleans from which 50,520 cubic yards of gravel were hydraulicked. Several small placer operations in the Weitchpec district yielded a total of 34 ounces of gold and 5 ounces of silver.

IMPERIAL COUNTY

The metal output of Imperial County in 1934 comprised 285 ounces of gold and 110 ounces of silver, valued together at $10,044, compared with $6,369 in gold and silver in 1933. The principal production in 1934 was from the Cargo Muchacho district where four small lode properties yielded 253 ounces of gold and 105 ounces of silver; a few small placer operations in this district and in the Mesquite and Picacho districts contributed the remainder of the county output.

INYO COUNTY

The output of Inyo County in 1934 was 7,614 ounces of gold, 40,130 ounces of silver, 35,849 pounds of copper, 553,007 pounds of lead, and 721,719 pounds of zinc, valued in all at $346,415, an increase of 236 percent over $103,124 in 1933.

Carbonate district.—The Carbonate mine 40 miles northeast of Zabriskie shipped 220 tons of lead ore in 1934 to the Selby smelter.

Cerro Gordo district.—From the Estelle-Cerro Gordo mine, 5 miles east of Keeler, the largest producer in the Cerro Gordo district in 1934, 1,559 tons of lead and zinc ores were shipped to the Selby and Richmond (Calif.) smelters and to Grasselli, Ind. From the Santa Rosa mine, 26 miles east of Keeler, 431 tons of silver-lead ore were shipped to the Midvale smelter. The total output of the district was 2,065 tons of ore yielding 151 ounces of gold, 24,048 ounces of silver, 20,679 pounds of copper, 405,992 pounds of lead, and 721,719 pounds of zinc. The Cerro Gordo was the only zinc-producing district in the State in 1934.

Chidago district.—The Cardinal mine, 21 miles southwest of Bishop, was the largest gold producer in Inyo County in 1934. The Cardinal Gold Mining Co. built a 150-ton flotation mill during the year and treated 16,924 tons of ore and 54 tons of old tailings; concentrates were shipped to the Midvale smelter.

Chloride Cliff district.—The output of the Chloride Cliff district in 1934 came largely from the McCrea group of mines west of Rhyolite, Nev.

Coso district.—The Max Welton and Wm. P. Stratton (Ross) lode mines were the leading producers in the Coso district in 1934.

Darwin district.—The principal producers in the Darwin district in 1934 were the Eagle and Coffin lode mines.

Fish Springs district.—The Cleveland mine near Bigpine made the largest output in the Fish Springs district in 1934; 148 tons of ore yielding 386 ounces of gold, 306 ounces of silver, and 553 pounds of copper were shipped to the Midvale smelter. At the Commetti mine 65 tons of ore were treated in a 3-stamp mill before leasing operations were suspended in February.

Lone Pine district.—From the Big Horn mine, 16 miles east of Lone Pine, 42 tons of ore were shipped in 1934 to the Midvale smelter; 140 ounces of gold, 647 ounces of silver, 922 pounds of copper, and 6,900 pounds of lead were recovered, and the property was the largest producer in the Lone Pine district. A 10-ton amalgamation mill was installed at the Finance mine near Keeler, and 317 tons of ore were treated.

South Park district.—Virtually all the output in the South Park district in 1934 was from lode mines; the Mizpah and Radcliff were the leading producers.

Union district.—The Reward (Brown Monster) mine yielded virtually all the lode output of the Union district in 1934. The placer production was derived by dry washing at the Last Chance mine northeast of Kearsarge.

White Mountain district.—The entire output of the White Mountain district in 1934 was from lode mines. The Poleta mine, 8 miles east of Bishop, was by far the largest producer; 441 tons of ore were treated in its 15-ton amalgamation and flotation plant and yielded 322 ounces of gold, 157 ounces of silver, 225 pounds of copper, and 353 pounds of lead; the 24 tons of concentrates produced were shipped to the Midvale smelter. The Southern Bell and Century mines near Laws were the next largest producers; the former treated 110 tons of ore by amalgamation in its 3-stamp mill, and the latter shipped 48 tons of ore to the Burton Bros. cyanide plant at Rosamond.

KERN COUNTY

The metal production of Kern County in 1934 was 29,237 ounces of gold, 113,646 ounces of silver, 3,511 pounds of copper, and 10,929 pounds of lead, valued in all at $1,096,002, an increase of 150 percent over $438,394 in 1933. Kern ranked seventh among the counties in total value of output in 1934.

Agua Caliente district.—The Hart mine, 9 miles east of Caliente, was the only sizable producer in the Agua Caliente district in 1934; at this property 250 tons of ore were treated in a 12-foot arrastre and yielded 193 ounces of gold and 75 ounces of silver.

Cove district.—Virtually the entire output of the Cove district in 1934 came from the Big Blue mine, 50 miles east of Bakersfield. The property is equipped with a 100-ton flotation mill which treated 20,134 tons of ore yielding 234 tons of concentrates.

Goler district.—The output of the Goler district in 1934 was derived from small placer operations. The largest producer was the Fine Gold group in Goler Gulch, 6 miles north of Randsburg; it is a drift mine and yielded 112 ounces of gold and 18 ounces of silver from 700 cubic yards of gravel.

Greenhorn Mountain district.—The principal output in the Greenhorn Mountain district in 1934 came from small lode operations. The largest producer was the Stonewall mine 45 miles west from Shoshone; it yielded 57 ounces of gold and 15 ounces of silver from about 90 tons of ore treated in an arrastre.

Mojave district.—The larger part of the gold and silver produced in the Mojave district in 1934 came from lode mines. The leading producer in the district was the Silver Queen mine on Soledad Mountain; it was discovered in the spring of 1933 and was heralded as one of the most important mining strikes in California in recent years. In 1934, 567 tons of ore from this property were treated at the Burton Bros. cyanide plant at Rosamond, and 9,755 tons were shipped to smelters at Selby, Calif., Tooele and Midvale, Utah, and Tacoma, Wash. The second largest producer, the Tropico mine 14 miles north of Rosamond, produced 6,965 tons of ore which was cyanided in the Burton Bros. 80-ton plant. The ore was ground to 30-mesh in cyanide solution, after which it was classified, the sands leached, the slimes agitated, and the solutions precipitated on zinc shavings.

Pioneer district.—The bulk of the output of the Pioneer district in 1934 came from lode mines. The principal producers were the Glenn Olive, 57 miles east of Bakersfield, where 391 tons of ore were treated in a 10-stamp mill; the Keyes near Isabella; and the Monarch, 45 miles northeast of Bakersfield, where a 2-stamp mill treated 80 tons of ore. The New Gold placer at Isabella produced 40 ounces of gold.

Rademacher district.—The only sizable producer in the Rademacher district in 1934 was the Bung Hole lode mine. A few small placer operations produced 19 ounces of gold by dry washing.

Randsburg district.—In the Randsburg district of Kern County the largest producer in 1934 was the Yellow Aster mine about 12 miles north of Randsburg. During the early part of the year the Randsburg-Aster Gold Mining Co. treated approximately 44,400 tons of old tailings from this mine in its 150-ton cyanide plant before selling its holdings to the Anglo-American Mining Co. in October. The Anglo-American Mining Co. remodeled the mill at the property into a 250-ton amalgamation and flotation plant and increased the capacity of the cyanide plant to 200 tons; 39,516 tons of ore and 17,899 tons of old tailings were treated, and 129 tons of concentrates were shipped to the Selby smelter. The ore, crushed to 1½-inch size, was stamped to pass a 40-mesh screen; after amalgamation it was floated without regrinding. The tailings were leached without regrinding.

The second largest producer in the district was the King Solomon mine at Randsburg. The property was operated with lessees by the International Mining & Milling Co., and 7,544 tons of ore and 5,423 tons of old tailings were treated; the latter were cyanided in two small leaching vats of 9- and 18-ton capacity, respectively. The third largest producer was the Susanna mine, from which 11,057 tons of ore were shipped to the Burton Bros. cyanide plant at Rosamond. The fourth largest producer was the Buckboard mine, where approximately 6,000 tons of crude ore were crushed in a 10-stamp mill and treated by amalgamation and 1,200 tons of old tailings were cyanided in a small leaching plant. These four mines produced a total of 10,241 ounces of gold and 4,698 ounces of silver. Many small placer operations in the district yielded a total of 525 ounces of gold and 96 ounces of silver.

Other districts.—The Black Bob, China Grade, Clear Creek, Long Tom, Piute, and Woody districts produced a total of 401 ounces of gold, 2,478 ounces of silver, and 107 pounds of copper from various small lode and placer properties.

KINGS COUNTY

In 1934 Kings County produced 20 ounces of gold valued at $694 and a few ounces of silver from two small lode mines in the Hanford district.

LASSEN COUNTY

The metal output of Lassen County in 1934 came from the Hayden Hill district and comprised 420 ounces of gold, 430 ounces of silver, and 177 pounds of copper, valued in all at $14,981, compared with a county output valued at $8,466 in 1933. The largest producers were the Juniper 20 miles east of Bieber and the Honey Lake near Doyle; the ore from both properties was shipped to smelters.

LOS ANGELES COUNTY

Los Angeles County produced 1,657 ounces of gold, 827 ounces of silver, 495 pounds of copper, and 4,026 pounds of lead in 1934, valued in all at $58,648, compared with an output valued at $16,098 in 1933.

Cedar district.—The only sizable output of gold in the Cedar district in 1934 was credited to the Governor (New York) lode mine 3 miles north of Acton.

Pacoima district.—The sole producer in the Pacoima district in 1934 was the Allison lode mine 24 miles northeast of Glendora, which was operated continuously; 97 ounces of gold and 29 ounces of silver were recovered from 800 tons of ore ground in a 20-ton ball mill and amalgamated in a bowl-type amalgamator.

San Gabriel district.—The Stanley-Miller lode mine 30 miles southwest of Glendora was the largest producer in the San Gabriel district in 1934; 38 ounces of gold and 10 ounces of silver were recovered from 210 tons of ore treated by amalgamation. Placer operations along the San Gabriel River yielded 802 ounces of gold and 199 ounces of silver—most of the district output.

Valyermo district.—The only producer in the Valyermo district in 1934 was the Big Horn lode mine at Valyermo, which yielded several hundred ounces of gold and a little silver, copper, and lead.

Other districts.—In the Azusa and Saugus districts in 1934 a few small lode and placer mines produced 82 ounces of gold and 9 ounces of silver.

MADERA COUNTY

The output of Madera County in 1934 was 377 ounces of gold and 107 ounces of silver, valued together at $13,232, compared with an output valued at $9,907 in 1933.

Potter Ridge district.—Nearly two thirds of the county gold production in 1934 came from the Potter Ridge district. The largest producers were the Enterprise mine 3 miles northeast of Grub Gulch, where 178 tons of ore were treated in a 10-stamp mill, and the Spangler mine 9 miles northeast of Raymond, where 200 tons of ore treated in a 2-stamp mill yielded 29 ounces of gold and 16 ounces of silver. More than half the district gold output came from small placer operations.

Other districts.—An output of 134 ounces of gold and 50 ounces of silver was made in 1934 by small lode and placer mines in the Coarse Gold, Daulton, and Hildreth districts.

MARIPOSA COUNTY

Mariposa County produced 14,805 ounces of gold, 4,971 ounces of silver, and 1,021 pounds of copper in 1934, valued in all at $520,739, an increase of 104 percent over $255,790 in 1933.

Colorado district.—The only sizable production in the Colorado district in 1934 was from the Buffalo mine 8 miles northeast of Mariposa, which yielded several hundred ounces of gold and a small quantity of silver. The Malone mine 7 miles northeast of Mariposa and the Eureka mine near Midpines produced less than 50 ounces of gold each.

Hite Cove district.—The output of the Hite Cove district in 1934 was derived from the Original mine on the Merced River 6 miles west of El Portal and the Feliciana mine 10 miles north of Mariposa.

Hunter Valley district.—The largest producer in the Hunter Valley district in 1934 was the Pyramid mine near Merced Falls, where 200 tons of ore were treated in a 5-stamp mill; the second was the Ruth Pierce mine 4 miles east of Hornitos, where 5,000 tons of old tailings were cyanided in two 15-ton tanks and yielded 284 ounces of gold and 164 ounces of silver; and the third was the Orange Blossom mine near Hornitos. More than half the district placer yield came from the Martinez mine 7 miles east of Hornitos.

Mother Lode district.—The outstanding producer in the Mother Lode district of Mariposa County in 1934 was the Pacific Mining Co., which operated the Pine Tree and Josephine mines 2½ miles south of Bagby. The company treated in its 100-ton flotation mill 32,400 tons of ore yielding 5,877 ounces of gold, 1,525 ounces of silver, and 924 pounds of copper; the concentrates (476 tons) were shipped to the Selby and Tacoma smelters. The ore was crushed to 2½-inch size, ground to 60-mesh in a Hardinge ball mill, classified by a Dorr classifier, and floated in 4 rougher cells, 2 scalper cells, and 2 cleaner cells (Kraut). During the year 1,545 feet of development work were done in the mine. The next largest producers were the Doss mine 3 miles south of Hornitos and the Virginia mine 3 miles south of Coulterville. There was a little placer mining on Bear, Cottonwood, Maxwell, Mariposa, and Sherlock Creeks.

Quartzburg district.—The only sizable producers in the Quartzburg district in 1934 were the Duncan mine 8 miles west of Hornitos, where 600 tons of dump ore were treated by amalgamation, and the Jumper mine 9 miles southeast of Bagby, where 60 tons of ore were treated by amalgamation. The Jumper mine was operated 9 months.

White Rock district.—The only producer in the White Rock district in 1934 was the Red Flag placer mine on Mariposa Creek near Chowchilla, where 2,500 cubic yards of gravel handled between March 1 and May 1 yielded 22 ounces of gold and 1 ounce of silver.

Whitlock district.—The Diltz mine 10 miles south of Mariposa was the outstanding producer in the Whitlock district in 1934. It was operated throughout the year, and development work comprised 200 feet of shaft and about 400 feet of drifts and raises; the 50-ton stamp mill treated 9,632 tons of ore by amalgamation. The Miners Hope (Spread Eagle group) mine 7 miles northwest of Mariposa produced 602 tons of ore which was treated by amalgamation in its 5-stamp mill. The Ramsden (B & M) mine near Mariposa produced considerable ore also.

MERCED COUNTY

The only mining in Merced County in 1934 was at placers in the Snelling district and yielded 17,130 ounces of gold and 1,625 ounces of silver, valued together at $599,746, an increase of 33 percent over $451,633 in placer gold and silver in 1933. Merced ranked tenth among the counties in total value of output in 1934. Virtually all the production was from the dredges of the Yuba Consolidated Gold

Fields and the Snelling Gold Dredging Co. The former company operated ground 4 miles east of Snelling with a 9-cubic foot, 62-bucket electric dredge having a daily capacity of 7,500 cubic yards and handled 2,687,706 cubic yards of gravel. The latter company ran a 6½-cubic foot, 66-bucket electric dredge with a daily capacity of 6,000 cubic yards and handled 3,152,465 cubic yards of gravel. There was also a small yield of platinum metals from the district.

MODOC COUNTY

The metal output of Modoc County in 1934 was 181 ounces of gold and 103 ounces of silver, valued together at $6,390, compared with $1,359 in gold and silver in 1933. Several small lode and placer mines in the Winters and High Grade districts supplied the entire output in 1934.

MONO COUNTY

Mono County produced 1,605 ounces of gold, 21,255 ounces of silver, 495 pounds of copper, and 7,487 pounds of lead in 1934, valued in all at $76,614, compared with an output valued at $34,595 in 1933.

Blind Springs district.—The only output in the Blind Springs district in 1934 was 2 tons of ore shipped from the Comanche mine near Benton to a smelter.

Bodie district.—The largest producer in the Bodie district in 1934 was the Standard mine 45 miles from Thorne, Nev. This property is equipped with a 20-stamp mill that treated 616 tons of ore by amalgamation and concentration; 10 tons of concentrates were shipped to the Selby smelter. The next largest producer was the Casa Diablo (Blue Bird) mine 24 miles northwest of Laws, from which 19 tons of ore were shipped to the custom cyanide plant of Burton Bros. at Rosamond and 76 tons to the smelter at Midvale. The third largest producer was the Syndicate mine, adjoining the Standard mine on the north.

Chidago district.—The entire output of the Chidago district in 1934 was from lode mines. The only sizable producer in the Mono County section of the district was the Long Chance mine 14 miles west of Hammil, from which 339 tons of ore were shipped to the Olds and Beauregard custom flotation mill at Bishop and 223 tons to smelters at Garfield and Midvale, with a total return of 408 ounces of gold, 643 ounces of silver, 294 pounds of copper, and 2,358 pounds of lead.

Homer district.—The only lode-gold production in the Homer district in 1934 came from the Old Mexico mine 95 miles southeast of Minden, Nev., from which 55 tons of ore shipped to the custom mill at Bodie yielded 101 ounces of gold and 48 ounces of silver. The rest of the district output came from placer operation.

Patterson district.—The only lode producer in the Patterson district in 1934 was the Silverado mine 60 miles south of Minden, Nev., operated by the Sierra Consolidated Mines, Inc., which treated 1,714 tons of ore in its 50-ton all-slime cyanide plant and recovered 28,567 ounces of silver and 29 ounces of gold. The mine was in operation from October 6 to December 31, and 2,000 feet of development work were done.

MONTEREY COUNTY

The production in Monterey County in 1934 was from the Los Burros district and totaled 15 ounces of gold and 1 ounce of silver, valued together at $518.

NEVADA COUNTY

Nevada County produced 203,678 ounces of gold, 314,309 ounces of silver, 99,272 pounds of copper, and 129,869 pounds of lead in 1934, valued in all at $7,334,488, an increase of 55 percent over $4,740,600 in 1933. Nevada ranked first among the counties in total value of output in both years.

French Corral district.—The Manzanita drift placer one-half mile north of Nevada City, the only sizable producer in the French Corral district in 1934, yielded 174 ounces of gold and 28 ounces of silver from approximately 800 cubic yards of gravel.

Grass Valley-Nevada City district.—In 1934, as in 1933, the Grass Valley-Nevada City district ranked first among the districts of the State as a gold producer and in total value of metal output. The metals produced in 1934 were valued at $6,922,845. The outstanding producer was the Empire Star Mines Co., Ltd. (Empire, Pennsylvania, North Star, Sultana, Murchie, and Zeibright lode mines), at Grass Valley, which treated 352,813 tons of ore by amalgamation and flotation; most of the concentrates produced were cyanided, but a few hundred tons were shipped to the Selby smelter. The annual report of the company for the year ended December 31, 1934, states that development in the Empire, Pennsylvania, and North Star mines was continued at a very high rate compared with the quantity of ore mined. Over 25,000 feet of drifts, crosscuts, and raises were driven, and 2,725 feet of diamond drilling were done. The Prescott Hill shaft at the Sultana mine was reopened and unwatered. The new ore body in the North Star mine was shown to extend upward from the 8,600-foot level for about 1,100 feet along the dip where it pinches out. An underground inclined shaft was collared at the 8,600-foot level and sunk 200 feet, where it was still in ore; it was planned to extend this incline 1,000 feet. The existence of 400,000 tons of reasonably assured ore having an average content of 0.386 ounce of gold per ton was reported as of January 1, 1935, compared with 257,000 tons containing 0.359 ounce per ton as of January 1, 1934, notwithstanding an extraction during 1934 of 250,768 tons containing 0.370 ounce per ton. Leasers in the abandoned levels of the North Star mine produced 23,217 tons of ore, from which 7,718 ounces of gold were recovered. Total operating costs were $8.09 per ton in 1934 compared with $7.29 in 1933 and $6.97 in 1932. The increase in costs was due to advances in wages and high development costs necessary to maintain reserves. The Murchie mine produced 91,760 tons of ore containing 0.350 ounce of gold and 1.28 ounces of silver per ton. The ore showed continued depreciation in grade with increase in depth from the 1,150- to the 1,600-foot (bottom) level. A vertical winze was collared at the 1,600-foot level and was to be sunk to the 2,050-foot level. Total operating costs of producing concentrates at this property were $7.24 per ton of ore, including development. The ratio of concentration was 46½:1 and the recovery 93.5 percent of the gold and 89.8 percent of the silver. At the Zeibright mine 10,285 tons of ore milled had an average content of about 0.087 ounce of gold per ton. A very large tonnage of such ore was reported available, and the company believed that by selective mining the gold content of the tonnage extracted could be maintained at about 0.10 ounce per ton. The second largest producer in the district and lode-gold producer in the State was the Idaho-Maryland mine at Grass Valley, operated by the Idaho-Maryland Mines Co. The company treated 80,237 tons of ore and 28,341 tons of old tailings by amalgamation and flotation; some of the concentrates were cyanided, and some were shipped to the Selby smelter. The following description of the operations of the company was extracted from its annual report for the year ended December 31, 1934. During the year 80,237 tons of ore were produced with a gross recovery per ton of $18.355 compared with $16.412 in 1933; the total tailing losses including those of the cyanide treatment were $1.246, making a gross value per ton of ore mined of $19.601. Of the total tonnage, 32,385 tons were derived from development and 47,852 tons from stoping operations. The Idaho-Maryland produced 63,690 tons, of which 18,950 tons were derived from development and 44,740 tons from stoping. Active development of the Brunswick mine was begun in May, and during the remainder of the year 16,547 tons of ore were produced, of which 13,435 tons were from development and 3,112 tons from stoping. Operating expenditures, including development, overhead, compensation insurance, taxes, metallurgical experiments, and cost of alteration and repairs to plant and equipment, were $11.028 per ton compared with $8.594 in 1933. This increase of $2.434 in cost per ton milled was caused largely by increased wages, increased development work, a campaign of diamond drilling, and expansion of improvements and betterments. During the year 12,488 feet of development were done compared with 7,490 feet in 1933. From this development 32,385 tons of ore and 47,852 tons of waste were produced. The development was accomplished at an average cost of $4.950 per ton of ore milled compared with $3.245 in 1933 and increased the ore reserves by about 196,500 tons. In the Idaho-Maryland the development extended the limits of known ore bodies and developed for extraction blocks of ore between the 1,300- and 1,000-foot levels. Development in the Brunswick mine consisted of exposing known veins immediately adjacent to the shaft. A cyanide plant with a daily capacity of 25 tons was completed for the treatment of concentrates and placed in operation March 26. A fine-grinding and flotation plant started operations in May. In September additional milling capacity was needed, and construction of a coarse-crushing unit was begun. This unit, including an 8- by 6-foot Marcy mill, a Dorr classifier, and large ore bins, was completed in November, and at the close of the year the plant was treating 225 tons of ore per day from the Idaho-Maryland and tailings from the stock pile. The tailings from the flotation plant contained 0.025 to 0.03 ounce of gold per ton. At the end of the year the Brunswick mill was being operated at a maximum capacity of 180 tons per day on ore from the Brunswick mine, which began producing in June. The third largest producer in the district was the Golden Center mine in Grass Valley, where a total of 19,300 tons of ore was treated by amalgamation and concentration and yielded 456 tons of concentrates which were shipped to the Selby smelter. The mine is equipped with a 20-stamp mill and a 125-ton flotation unit. The discharge from the amalgamation plates is classified in a Simplex classifier in closed circuit with a ball mill which grinds the coarse pulp. The classifier overflow is treated in two 4-cell flotation rougher units and a 2-cell cleaner unit, the tails from which are returned to the roughers; the tails from the roughers are cleaned on a concentrating table. The mine is developed by a 1,300-foot inclined shaft and about 20,000 feet of drifts, crosscuts, and raises. Approximately 3,500 feet of development work were done in 1934. The fourth largest producer in the district was the Lava Cap mine 5 miles east of Nevada City, from which 46,306 tons of ore were treated by amalgamation and flotation, producing 2,447 tons of concentrates shipped to various smelters and yielding 6,514 ounces of gold, 71,380 ounces of silver, 6,633 pounds of copper, and 996 pounds of lead. The mine is equipped with a 300-ton flotation mill. During 1934 a thickener tank and a Denver flotation cell were added to the mill equipment, and 8,500 feet of development work were done. The fifth largest producer in the district was the Empress mine 5 miles northwest of Grass Valley, acquired by the Republic Gold Mining Corporation in October; 12,762 tons of ore were milled and yielded 258 tons of concentrates, which were shipped to the Selby smelter. A new 200-ton flotation mill was begun in November. About 875 feet of drift, raises, and winzes were driven in 1934. Other lode mines in the district having sizable yields were the Hoge, San Juan, and the Canada Hill-Hussey-Ragan-Queen Lil group. The chief producer among the placer operations was the Alta Hill drift mine one-half mile north of Grass Valley, which treated 9,400 cubic yards of gravel; the property is equipped with a 100-ton screening and washing plant. The mine was unwatered in March and operated continuously to the end of the year; about 700 feet of drifts and raises were driven.

Washington district.—The largest producer in the Washington district in 1934 was the Spanish mine, 21 miles northeast of Nevada City, from which 26,415 tons of ore treated by cyanidation yielded 218 tons of concentrates shipped to the Selby smelter; the total recovery was 5,778 ounces of gold, 48,173 ounces of silver, and 5,707 pounds of copper. The property is equipped with a 100-ton concentration mill and a 100-ton cyanide plant; the ore is treated by flotation, and the tailings are cyanided. The mine and mill operated the entire year. The second largest producer was the Ancho Erie mine 30 miles east of Graniteville; 6,409 tons of ore treated by amalgamation and concentration in its 20-ton stamp mill yielded 65 tons of concentrates, which were shipped to smelters. The mine operated the entire year. The outstanding placer operation was at the Omega mine 3 miles southeast of Washington, where about 65,000 cubic yards of gravel were hydraulicked. The Davis placer mine about 2 miles north of Washington yielded 279 ounces of gold and 46 ounces of silver. River Placers, Ltd., drove a 600-foot hard-rock tunnel to divert the Middle Yuba River to permit excavation of its placer ground by an electric drag line; the property was in operation before the close of the year and made a small output.

You Bet district.—The outstanding producer in the You Bet district in 1934 was the You Bet hydraulic mine 13 miles east of Grass Valley; 157,073 cubic yards of gravel were moved with two giants.

ORANGE COUNTY

The only production in Orange County in 1934 was from placers in the Lucas Canyon district which yielded 16 ounces of gold and 2 ounces of silver, valued together at $573.

PLACER COUNTY

The metal output of Placer County in 1934 comprised 15,676 ounces of gold, 10,808 ounces of silver, and 338 pounds of copper, valued in all at $554,906, an increase of 230 percent over $168,249 in 1933.

Auburn district.—The principal gold producer in the Auburn district in 1934 was the Crocker Ranch placer, where 3,500 cubic yards of gravel were handled with a power shovel and screening plant.

Colfax district.—Practically all the gold and silver produced in the Colfax district in 1934 came from very small placer operations. The Annie Laurie mine 5½ miles southeast of Colfax was the principal lode producer.

Dairy Farm district.—The only producer in the Dairy Farm district in 1934 was the Dairy Farm mine 11 miles north of Lincoln; 28,099 tons of ore were cyanided in a 100-ton plant. The ore was crushed to approximately one-fourth-inch size before leaching, and precipitation was effected in a Merrill-Crowe plant.

Dutch Flat district.—The Rawhide lode mine 5 miles east of Towle yielded the largest output of gold in the Dutch Flat district in 1934; the 50-ton mill at the property is equipped with a ball mill, amalgamating plates, and concentrating tables and treated 5,600 tons of ore during the year. At the Black Hawk mine 4 miles from Towle 700 tons of ore were treated by amalgamation and concentration in a 10-stamp mill; the discharge from the amalgamation plates went to 3 Fagergren flotation cells, the tailings from which were cleaned by 5 vanners. The largest yield of placer gold was from the Dutch Flat Townsite drift mine, where 5,000 cubic yards of gravel were washed. At the Banner and Flying Fish drift placer claims in Dutch Flat Canyon approximately 1,400 cubic yards of gravel were handled and yielded a little gold. The Trixie placer mine, one-half mile from Dutch Flat, yielded 36 ounces of gold.

Forest Hill district.—Most of the production in the Forest Hill district in 1934 was from placers. The largest yield was from the Paragon hydraulic mine 2 miles northeast of Foresthill, where 33,500 cubic yards of gravel were handled with 3 giants in 5 months. The next largest placer producers were the Lackawanna and Small Hope. The De Maria, Three Queens, and Seven-Eleven lode mines yielded small outputs of gold and silver.

Gold Run district.—The entire output of the Gold Run district in 1934 came from placer operations. The Oro Bell Dredging Co., the only sizable producer, began operations in June with a 4-cubic foot, 76-bucket dredge and worked intermittently during the rest of the year; the yardage handled yielded 17.5 cents per cubic yard.

Iowa Hill district.—The Victory lode mine, near Cedar Springs, and the Gleason placer, 3 miles south of Iowa Hill, were the leading gold producers in the Iowa Hill district in 1934.

Last Chance district.—The largest gold producers in the Last Chance district in 1934 were the Liberty Hill, Hometicket, and Glenn mines. At the Hometicket drift placer, 1 mile east of Last Chance in Grouse

Canyon, about 600 cubic yards of tailings were handled, and 493 ounces of gold and 44 ounces of silver were recovered.

Michigan Bluff district.—The largest producer in the Michigan Bluff district in 1934 was the American Bar mine, 40 miles north of Auburn, where 2,167 tons of ore treated by amalgamation and concentration yielded 329 ounces of gold and 77 ounces of silver; the concentrates were stacked for cyanidation upon installation of leaching tanks. The 20-stamp mill at the property and the water-conveying system (5 miles of ditch and flume) were rehabilitated.

Ophir district.—The outstanding producer in the Ophir district in 1934 was the Auburn-Chicago mine, 1 mile east of Penryn; 4,344 tons of ore were treated in a 35-ton amalgamation and concentration mill with three flotation units. The ore was treated by tabling and the high-grade table streak cut for pan amalgamation; the tailings from the tables were floated. The mine operated 360 days, and approximately 2,570 feet of development work were done. The second largest producer was the Alabama mine, also 1 mile east of Penryn, where approximately 5,600 tons of ore yielded 902 ounces of gold and 900 ounces of silver; 21 tons of concentrates were produced. The mine is equipped with a 10-stamp mill, and both mine and mill operated continuously after January. The ore was treated by amalgamation and flotation, and a Deister table was used as a scavenger to clean flotation tailings. Over 700 feet of raises and drifts were driven.

Other districts.—The combined output of the Butcher Ranch, Miners Ravine, and Tahoe districts in 1934 was 181 ounces of gold, 131 ounces of silver, and 338 pounds of copper.

PLUMAS COUNTY

The metal output of Plumas County in 1934 was 4,379 ounces of gold, 1,111 ounces of silver, 716 pounds of copper, and 2,939 pounds of lead, valued in all at $153,940, compared with an output valued at $70,410 in 1933.

Butte Valley district.—Virtually the entire output of the Butte Valley district in 1934 came from placer operations. The largest producer was the Cameron Group, on the North Fork of Feather River 2 miles from Seneca, which yielded 91 ounces of gold and 12 ounces of silver from sluicing. The next largest gold yields were from the Nugget, Sunnyside, Smith Bar, and Glacier placer mines.

Crescent Mills district.—The New York mine, three fourths of a mile from Greenville, was the largest producer in the Crescent Mills district in 1934; approximately 2,000 tons of ore treated by amalgamation and concentration yielded 154 ounces of gold and 30 ounces of silver. The Gold Stripe lode mine, 6 miles southwest of Greenville, made from about 200 tons of ore the second largest output of gold; the 4-stamp mill at the property has a daily capacity of 8 tons. Among the other lode producers were the Premium, 4 miles southeast of Crescent Mills, and the Standart, 1½ miles south of Greenville.

Genesee district.—Virtually the entire output of the Genesee district in 1934 came from placer operations. The largest yield was from the Lott property, 5 miles west of Belden, and the next largest from the De Lone placer on Squirrel Creek, 2 miles northwest of Spring Garden, where about 500 cubic yards of gravel yielded 56 ounces of gold.

Johnsville district.—The only large producer of gold in the Johnsville district in 1934 was the Plumas Eureka placer property; it was worked with a power shovel, and the gravel and slide rock were hauled in 5-ton trucks to a screening and washing plant. About 50 tons of tailings from the Plumas Eureka lode mine yielded 21 ounces of gold, 17 ounces of silver, and 2,939 pounds of lead.

La Porte district.—The gold production of the La Porte district in 1934 was the largest in Plumas County and came entirely from placer operations. The only large producer was the Bunker Hill drift mine, 14 miles northeast of La Porte, where 403 ounces of gold and 31 ounces of silver were recovered from about 10,000 cubic yards of gravel.

Lights Canyon district.—The lode-gold output of the Lights Canyon district in 1934 came entirely from the Lucky Strike mine. The only noteworthy placer producer was the Lucky (Oro Placer No. 1) at the head of Peter Creek 1½ miles northwest of Kettle Rock; about 300 cubic yards of slide rock were washed.

Other districts.—Nominal outputs of gold were made in 1934 by a few small lode and placer mines in the North Fork Feather River, Quincy, and Sawpit Flat districts.

RIVERSIDE COUNTY

Riverside County produced 1,199 ounces of gold, 664 ounces of silver, 1,598 pounds of copper, and 1,207 pounds of lead in 1934, valued in all at $42,501, compared with an output valued at $15,139 in 1933.

Bendigo district.—All the output of the Bendigo district in 1934 was from lode mines. The only sizable producer was the Lone Pine mine, from which ore was shipped to the custom cyanide plant of Burton Bros. at Rosamond. The Alice and Reliance, Mountaineer, and Gold Dollar Group made small outputs of gold.

Chuckawalla district.—The leading producers in the Chuckawalla district in 1934 were the Chuckawalla mine 1½ miles southwest of Corn Springs and the Huff mine 42 miles northeast of Mecca. At the Golden Key mine 45 miles west of Blythe 26 tons of ore treated by amalgamation yielded 17 ounces of gold and 3 ounces of silver. All the placer operations were very small.

Monte Negro district.—The Zula Queen mine 43 miles northeast of Mecca was the only producer in the Monte Negro district in 1934. The property is equipped with a 30-ton stamp mill, which handled 99 tons of ore by amalgamation and concentration.

Pinacate district.—All the output of the Pinacate district in 1934 came from small lode mines; the largest producers were the Hoag 10 miles west of Perris, equipped with a 12-ton stamp mill, and the Fortuna.

Pinon district.—The Blue Bell mine and the New Eldorado mine, both about 20 miles south of Twentynine Palms, were the chief producers of gold in the Pinon district in 1934. About 100 tons of ore from the Blue Bell mine were treated in neighboring mills, and 22 tons were shipped to the custom cyanide plant of Burton Bros. at Rosamond. The New Eldorado mine has a 10-stamp mill and a 20-ton cyanide plant which treated 700 tons of ore yielding 112 ounces of gold and 40 ounces of silver; the discharge from the amalgamation plates was cyanided without grinding. Some of the water used in milling was hauled from Twentynine Palms.

San Jacinto district.—The Good Hope lode mine 4½ miles southeast of Perris was the only producer in the San Jacinto district in 1934.

Other districts.—The Arica, Iron Wood, and Eagle Mountain districts made a combined output in 1934 of only 81 ounces of gold, 29 ounces of silver, and 86 pounds of copper.

SACRAMENTO COUNTY

Sacramento County produced 101,730 ounces of gold and 4,548 ounces of silver in 1934, valued together at $3,558,408, an increase of 19 percent over $2,998,437 in 1933. In both years the output came mostly from dredging operations and Sacramento ranked second among the counties in total value of production. The entire output came from the Folsom district, and only 48 ounces of gold and 61 ounces of silver in 1934 were from lode mines. The outstanding producers were the Natomas Co., the Capital Dredging Co., and the Gold Hill Dredging Co.

The Natomas Co. operated 6 dredges in 1934 until August 13, when dredge No. 2 was dismantled and its equipment sold to the Merced Dredging Co.; the remaining 5 dredges operated throughout the year. A total of 18,443,253 cubic yards of gravel was mined and yielded 59,437 fine ounces of gold (0.0032 ounce per cubic yard) compared with a total yield of 69,425 ounces from 18,290,841 cubic yards (0.0038 ounce per cubic yard) in 1933. The cost per yard was $0.0462 in 1934 compared with $0.0459 in 1933, but because of the increased price of gold in 1934 the gross value of the yield rose from $0.0981 per yard in 1933 to $0.1127 in 1934 and the gross proceeds from dredging operations from $1,794,611 to $2,079,027. During 1934 the Natomas Co. affiliated with a mining group for the purpose of dredging a new field in Merced County, and the Merced Dredging Co. was incorporated. As already stated, the Merced Dredging Co. purchased the equipment of dredge No. 2 from the Natomas Co. in August 1934. A new hull was built and the dredge placed in operation February 20, 1935. During 1934 the Natomas Co. prospected other areas in California but failed to find profitable ground. However, options were obtained on a large area near Manhattan, Nev., where preliminary investigations evidenced sufficient values to justify further exploration. The Capital Dredging Co. operated 3 electric dredges, 2 with one hundred and fifty-one 9-cubic foot buckets and 1 with eighty-eight 18-cubic foot buckets; these dredges operated steadily throughout the year and handled 9,963,620 cubic yards of gravel. The Gold Hill Dredging Co. operated an electric dredge 2 miles southeast of Folsom City; the dredge had sixty-six 7½-cubic foot buckets and handled 1,937,524 cubic yards of gravel. Over a hundred ounces of platinum metals were recovered in the clean-ups from all of the dredges. The Mississippi Bar placer on the American River was worked with a gasoline power shovel from which four trucks delivered the gravel to a washing plant; about 80,000 cubic yards of gravel were handled and yielded 571 ounces of gold. The Mocosumne placer on the Consumnes River at Bridge House was operated through August to December, and about 2,000 cubic yards of gravel yielded 120 ounces of gold. The Blue Ravine drift placer 4 miles northeast of Folsom City was also a sizable producer.

SAN BERNARDINO COUNTY

In 1934 San Bernardino County produced 8,641 ounces of gold, 228,314 ounces of silver, 22,893 pounds of copper, and 102,672 pounds of lead, valued in all at $455,221, an increase of 201 percent over $151,380 in 1933.

Buckeye district.—The only output in the Buckeye district in 1934 was from lode mines. Fourteen cars of gold ore were shipped to the Garfield and Midvale smelters from the Markesan mine 8½ miles south of Ludlow, and 677 tons were shipped from the Old Pete mine. The Dull Pick mine 9 miles southwest of Ludlow was also a producer.

Calico district.—The Burcham group 5 miles northwest of Yermo and the Sioux mine in the Calico Mountains 8 miles north of Daggett were the only producers in the Calico district in 1934.

Dale district.—The entire output of the Dale district in 1934 came from lode mines; the Brooklyn mine 50 miles northeast of Mecca was the only large producer. A 25-ton cyanide plant built at this property in 1934 to treat stamp-mill tailings started operation June 16 and ran the rest of the year; approximately 1,850 tons of old tailings were handled.

Hart district.—The Valley View mine 15 miles east of Ivanpah, equipped with a 10-stamp mill and a cyanidation plant, was the only producer in the Hart district in 1934.

Ivanpah district.—The Vanderbilt (Sidewinder) mine in the Ivanpah district 4 miles east of Ivanpah, equipped with a 25-ton concentration plant, was operated in 1934 from March to December 20; 884 tons of crude ore and the concentrates from 500 tons of ore concentrated were shipped to the Garfield smelter. Lessees at the Bronze mine 5 miles east of Ivanpah shipped 66 tons of ore to the Midvale smelter.

Kelso district.—The entire output of the Kelso district in 1934 came from lode mines. The outstanding producer was the Vulcan mine 10 miles southeast of Cadiz; 662 tons of ore yielding 449 ounces of gold and 61 ounces of silver were treated in a 20-ton amalgamation and concentration mill on the property. The ore was ground in closed circuit with a classifier to minus 80-mesh, amalgamated on four plates, and concentrated on a Wilfley table. The mine is developed by a 400-foot inclined shaft and 1,500 feet of drifts.

Randsburg district.—The Kelly mine at Red Mountain in the Randsburg district made the largest output of gold in San Bernardino County in 1934 and was the leading silver producer in the State. Flotation concentrates, with a silver-gold ratio of 68:1, were shipped to the Selby smelter, and approximately 700 tons of high-grade ore were shipped to the Selby and Tacoma smelters. Approximately 300 tons of ore with an average assay of 1.04 ounces of gold and 43.43 ounces of silver per ton were shipped to the Selby smelter from the Coyote group one-fourth mile south of Red Mountain. Lessees operated the Merced mine and treated over 200 tons of high-grade ore in the 5-stamp mill of the Black Hawk mine 15 miles north of Searles, which operated only on custom ore as there was no production from the mine. Two cars of ore were shipped from the Victory mine to the custom cyanide plant of Burton Bros. at Rosamond. Atolia Rand Placers, Inc., milled approximately 31,000 cubic yards of gravel from its claims 1 mile southwest of Atolia; water for milling was pumped to the property through a 4-inch pipe line 8 miles long.

Slate Range district.—Approximately 300 tons of lead ore with high gold values were shipped from the Slate Range district in 1934 to the Selby smelter. At the Patsy Lee mine about 500 tons of old tailings ground in a small ball mill and cyanided yielded 83 ounces of gold and 78 ounces of silver.

Other districts.—Miscellaneous districts in San Bernardino County yielded a total of 1,682 ounces of gold, 14,918 ounces of silver, 5,594 pounds of copper, and 54,749 pounds of lead.

SAN DIEGO COUNTY

The metal output of San Diego County in 1934 was 730 ounces of gold and 289 ounces of silver, valued together at $25,701, compared with $5,918 in gold and silver in 1933. Virtually all the output in 1934 came from the Julian district. The larger producers were the North Hubbard lode mine and the Mykrantz Ranch placer. The North Hubbard mine, 65 miles northeast of San Diego, is equipped with a 20-ton amalgamation and concentration mill, and both mine and mill were operated 9 months; 1,500 tons of ore yielded 350 ounces of gold and 206 ounces of silver. The 10 tons of concentrates produced were shipped to a smelter. The Mrkrantz Ranch placer on Garnet Creek operated from January 14 to March 15 and handled 8,188 cubic yards of gravel with a drag line operated by steam; 4 trucks loaded by the drag line hauled the gravel to a screening and washing plant.

SAN JOAQUIN COUNTY

Placer operations in the Bellota and Clements districts yielded the entire output of San Joaquin County in 1934, which was 32 ounces of gold and 3 ounces of silver, with a total value of $1,135.

SAN LUIS OBISPO COUNTY

A little lode gold from the Cambria district and placer gold from the La Panza district comprised the total output of San Luis Obispo County in 1934, which amounted to 56 ounces of gold and 8 ounces of silver, valued together at $1,951.

SANTA CRUZ COUNTY

Beach sands in the Santa Cruz district yielded 4 ounces of gold and 2 ounces of silver in 1934, valued together at $131.

SHASTA COUNTY

Shasta County produced 20,560 ounces of gold, 26,012 ounces of silver, and 388,473 pounds of copper in 1934, valued in all at $766,477, compared with an output valued at $680,410 in 1933. Shasta ranked ninth among the counties in total value of output in 1934.

Centerville district.—The Rich Strike Gold Mines, Ltd., operated the Yankee Jack and Boswell mines 7 miles west of Redding in 1934 and built a 50-ton flotation mill; 341 tons of ore were treated and yielded 11 tons of concentrates which were shipped to the Selby smelter. After being crushed to ¾-inch size the ore was ground in a Marcy ball mill in closed circuit with a Dorr classifier with a gold trap between them. The overflow from the classifier discharged to amalgamation plates and thence to a 6-cell flotation unit. Before operations by the Rich Strike Gold Mines, Ltd., were begun 1,200 tons of old mill tailings from the Yankee Jack mine were cyanided in a 20-ton leaching plant and yielded 93 ounces of gold. The Lone Hill placer, 8 miles southwest of Redding, was operated 48 days with a drag line; 134 ounces of gold were recovered from 11,973 cubic yards of gravel.

French Gulch district.—The American lode mine 3 miles northeast of French Gulch was the largest producer in the French Gulch district in 1934 and yielded about 400 ounces of gold. The Milkmaid mine equipped with a 100-ton flotation mill was another important producer.

Igo district.—A dry-land gasoline dredge handled 14,000 cubic yards of gravel in 1934 from the M. D. Baker placer on Dry Creek, 1 mile west of Igo, with a yield of 156 ounces of gold.

Iron Mountain district.—The Mountain Copper Co., Ltd., was the largest producer of gold, silver, and copper in Shasta County in 1934. The gold and silver were recovered by cyanidation of gossan from the Iron Mountain mine. The copper came largely from cupriferous residues—from pyrites shipped from the Hornet mine to manufacturers of sulphuric acid—leached in the company cementation plant at Martinez, Contra Costa County; a small quantity of copper also was recovered as cement copper from the mine water of the Iron Mountain mine.

Other districts.—Very small lode and placer mines in miscellaneous districts of Shasta County yielded a total of 1,873 ounces of gold, 398 ounces of silver, and 279 pounds of copper.

SIERRA COUNTY

Sierra County produced 29,402 ounces of gold, 7,032 ounces of silver, 531 pounds of copper, and 2,498 pounds of lead in 1934, valued in all at $1,032,262, an increase of 131 percent over $446,311 in 1933. Sierra ranked eighth among the counties in total value of output in 1934.

Alleghany district.—The Original Sixteen to One Mine, Inc., was the outstanding producer in the Alleghany district in 1934. Ore from the Sixteen to One and Tightner mines 40 miles north of Nevada City was treated by amalgamation and concentration in a 100-ton ball-mill plant and a 20-stamp mill which was operated part of the year; 36,101 tons were treated, and the concentrates were shipped to the Selby smelter. A 10-stamp mill was built at the Kenton mine 20 miles north of Nevada City and treated 2,844 tons of ore by amalgamation and concentration. Another large producer was the Oriental Gold Star mine 35 miles northeast of Nevada City; the 10-stamp mill at this property treated 9,800 tons of ore by amalgamation. The Scotia mine about 30 miles northeast of Nevada City was also an important producer of gold. The largest placer output in the district was from the Golden Bear drift mine on Rock Creek, where 2,080 cubic yards of gravel yielded 452 ounces of gold and 46 ounces of silver; the mine was operated from January 1 to September 22 when fire destroyed the mill and hoisting works, which are being rebuilt. Other sizable placer producers were the Ruby drift mine operated by leasers and the Fifty-Fifty on Kanaka Creek 1½ miles from Alleghany where 2,600 cubic yards of gravel were sluiced between January 1 and September 1.

Pike district.—At the Sierra Alaska mine 28 miles northeast of Nevada City, the only lode producer in the Pike district in 1934, lessees treated 46 tons of ore and 300 tons of old tailings by amalgamation and concentration early in the year. A new headframe was erected later, and unwatering of the mine shaft was begun preliminary to sampling the old workings.

Sierra City district.—The Sierra Buttes lode mine 60 miles northeast of Nevada City was the only important producer in the Sierra City district in 1934. The ore was crushed in a rod mill and concentrated on a table; it yielded 48 tons of concentrates which were shipped to smelters.

Other districts.—The American Hill, Downieville, Indian Hill, Poker Flat, Port Wine, and Slate Creek districts produced a total of 1,277 ounces of gold and 214 ounces of silver in 1934 from various small lode mines and placers.

SISKIYOU COUNTY

The metal output of Siskiyou County in 1934 comprised 15,119 ounces of gold, 2,879 ounces of silver, and 115 pounds of lead, valued in all at $530,260, compared with an output valued at $325,640 in 1933.

Elliott Creek district.—There was a nominal yield of gold and silver in the Elliott Creek district in 1934 from small lode mines and placers.

Klamath River district.—At the Reeves placer on the Klamath River 47,500 cubic yards of gravel were hydraulicked in 1934 and yielded the largest production in the Klamath River district. Equipment consisted of three giants which used 600 miner's inches of water under a 70-foot head, a hydraulic elevator with a daily capacity of 250 cubic yards, a 10-horsepower Pelton wheel, and an 8-kilowatt Westinghouse dynamo. The Seiad placer on the Klamath River about 1 mile from Seiad handled 20,000 cubic yards of gravel with two giants and yielded the next largest output of placer gold.

North Central district.—The Cal Oro Dredging Co. on Greenhorn Creek south of Yreka made the largest output of placer gold in Siskiyou County in 1934; an electric dredge with a daily capacity of 3,000 cubic yards handled about 350,000 cubic yards of gravel from February 16 to June 3, with a recovery of 2,237 ounces of gold and 260 ounces of silver. The New York lode mine 6 miles northwest of Fort Jones on Indian Creek was credited with a yield of over 250 ounces of gold. At the Mount Vernon mine 8 miles west of Yreka 263 tons of ore treated in a 15-ton amalgamation and concentration mill yielded 239 ounces of gold and 69 ounces of silver. The McConnell Bar placer on the Klamath River 12 miles north of Yreka was operated with a steam shovel but produced less than 100 ounces of gold. The Blue Gravel drift mine 1½ miles west of Hornbrook on Rancheria Creek yielded 86 ounces of gold.

Salmon River district.—The King Solomon mine 12 miles southeast of Sawyers Bar made the largest output of gold in the county in 1934; it came from the treatment of 86,558 tons of low-grade free-milling ore. At the Hansen mine 8 miles south of Forks of Salmon 1,132 tons of ore were treated in a 15-ton Amador (rocker-type) amalgamation mill having 40 square feet of apron plates. The Hickox placer 2½ miles north of Somesar, equipped with 3 giants, 1 Pelton-wheel derrick, and an air compressor, produced 193 ounces of gold and 25 ounces of silver. At the Summerville placer on the South Fork of Salmon River near Cecilville two No. 5 giants handled about 32,000 cubic yards of bench gravel, with a recovery of 126 ounces of gold and 17 ounces of silver.

Scott River district.—The Oro Grande mine 31 miles southwest of Gazelle made the largest output in the Scott River district in 1934. The ore (1,500 tons) was treated in a 100-ton flotation plant where it was ground to 65-mesh in a Hardinge ball mill; 60 tons of concentrates produced by flotation were shipped to the Selby smelter. The total recovery was 319 ounces of gold and 336 ounces of silver. The Old Turk mine approximately 8 miles southwest of Fort Jones was reopened in July, and about 800 tons of ore were treated in a leased mill; construction of a 10-stamp mill was begun in November. At the Tangle Blue mine 41 miles southwest of Gazelle 33 tons of ore shipped to the Selby smelter yielded 100 ounces of gold and 152 ounces of silver. Hydraulic operations were carried on throughout the year at the Quartz Hill mine on the Scott River one-half mile from Scott Bar.

STANISLAUS COUNTY

Stanislaus County produced 6,843 ounces of gold and 841 ounces of silver in 1934, valued together at $239,702, compared with $148,445 in gold and silver in 1933.

La Grange district.—The La Grange Gold Dredging Co., operating an electric dredge with seventy 9-cubic foot buckets and a daily capacity of 9,000 cubic yards at the La Grange placer on the Tuolumne River, was the largest producer of gold in Stanislaus County in 1934. Mining was carried on from January 1 to April 7 and from July 28 to December 31; 2,126,542 cubic yards of gravel were handled. The dredge was rebuilt during the period from April 7 to July 28. An operator worked ground 2 miles east of La Grange with two gasoline shovels with a daily capacity of 1,000 cubic yards each and recovered 644 ounces of gold and 48 ounces of silver.

Other districts.—The Knights Ferry and Oakdale districts produced a total of 131 ounces of gold and 29 ounces of silver in 1934 from various small lode mines and placers.

TEHAMA COUNTY

In 1934 Tehama County produced 33 ounces of gold and 3 ounces of silver, with a total value of $1,148, from small placer operations in the Los Molinos district. No production was reported from the county for 1933.

TRINITY COUNTY

The metal output of Trinity County in 1934 was 16,443 ounces of gold, 2,537 ounces of silver, and 179 pounds of copper, valued in all at $576,335, compared with an output valued at $346,633 in 1933.

Big Bar district.—The Osborn Hill placer on the Trinity River 1 mile southwest of Helena was the only sizable producer in the Big Bar district in 1934; approximately 83,500 cubic yards of gravel were hydraulicked with a giant using 700 miner's inches of water under a 250-foot head and having a daily capacity of about 500 cubic yards.

Helena district.—The Enterprise mine, 6 miles north of Helena, was the only property in the Helena district with a significant production in 1934; about 700 tons of ore were treated by amalgamation and concentration in a 10-stamp mill. A new concentrating table and a flotation cell were installed in December; the table was used as a scavenger to clean flotation tailings.

Junction City district.—Canyon Placers, Inc., at Dedrick and the Red Hill placer on the Trinity River about 2 miles west of Junction City were the largest producers of gold in the Junction City district in 1934. Canyon Placers was operated with six giants using 600 to 2,000 miner's inches of water under heads of 230 to 385 feet; the mine was active from January 1 to June 19, and 463,385 cubic yards of gravel were hydraulicked. At the Red Hill placer six giants, using a total of approximately 3,300 miner's inches of water, and a gasoline tractor were operated from May 15 to July 15 and from October 15 to December 31; 325,000 cubic yards of bench gravel were hydraulicked.

Lewiston district.—The Trinity Dredging Co., operating near Lewiston, was the outstanding producer in the Lewiston district in 1934; 1,162,126 cubic yards of gravel were mined with an 11-cubic foot, link-bucket dredge. At the Brown Bear mine near Deadwood approximately 5,200 tons of ore were treated in a 10-stamp mill by amalgamation and table concentration; English corduroy was used in the tailings race. A total of 143 tons of concentrates was shipped to the Selby smelter. The mine was operated one shift per day throughout the year, and the mill was operated 24 hours a day. At the Five Pines mine 40 miles northwest of Redding, a 2-stamp amalgamation mill treated 50 tons of ore. At the Mead placer on the Trinity River near Lewiston about 4,000 cubic yards of gravel were hydraulicked with two No. 1 giants, each using about 75 miner's inches of water under a 100-foot head.

New River district.—The only outstanding producer in the New River district in 1934 was the Gold Bar Dredging Corporation, which operated an electric dredge having forty-six 7-cubic foot buckets and handled 580,000 cubic yards of gravel.

Weaverville district.—At the Senger placer south of Weaverville 140,000 cubic yards of bench gravel were hydraulicked and yielded the largest gold output in the Weaverville district in 1934. Redding Creek Placers, Ltd., operated four giants on Redding Creek 7 miles south of Douglas City, washed 7,400 cubic yards of gravel from March 31 to June 15 and from December 8 to 31, and recovered 104 ounces of gold and 11 ounces of silver. The Hook and Ladder placer at Weaverville also produced a little gold by hydraulicking.

Other districts.—The Coffee Creek, Hay Fork, Salyer, and Trinity Center districts produced a total of 752 ounces of gold and 295 ounces of silver in 1934 from various small lode and placer mines.

TULARE COUNTY

The output of Tulare County in 1934 was 146 ounces of gold, 145 ounces of silver, and 1,799 pounds of lead, valued in all at $5,275, compared with an output valued at $2,166 in 1933. Deer Creek and White River were the only producing districts.

TUOLUMNE COUNTY

The metal output of Tuolumne County in 1934 comprised 7,704 ounces of gold and 1,775 ounces of silver, valued together at $270,403, compared with an output valued at $108,022 in 1933.

Columbia district.—The Big Dyke and Lazar lode mines, the Springfield drift mine at Table Mountain, the Draper lode mine, and the Sellick placer were the principal producers in the Columbia district in 1934.

East Belt district.—At the Columbus mine 2 miles north of Tuolumne, the outstanding producer in the East Belt district of Tuolumne County in 1934, 6,104 tons of ore were treated in a 30-ton amalgamation and flotation mill. The ore was crushed by stamps to 40-mesh, amalgamated, and concentrated by tabling; 80 tons of concentrates were shipped to the custom cyanide plant of the Amador Metals Reduction Co. at Jackson. The next largest output came from the Soulsby Belle mine 10 miles northeast of Sonora; 1,372 tons of ore were treated by amalgamation and concentration.

Mother Lode district.—The Senator mine 1½ miles west of Jamestown was credited with an output of more than 500 ounces of gold in 1934 and was the largest producer in the Mother Lode district of Tuolumne County.

VENTURA COUNTY

Ventura County produced 127 ounces of gold and 10 ounces of silver in 1934, valued together at $4,441, compared with an output valued at $1,672 in 1933. The entire output in both years came from the Piru district.

YOLO

The metal output of Yolo County in 1934 came from the Woodland district; it consisted of 5 ounces of gold and 1 ounce of silver, valued together at $177.

YUBA COUNTY

Yuba County produced 54,706 ounces of gold and 4,545 ounces of silver in 1934, valued together at $1,914,898, an increase of 71 percent over $1,119,032 in 1933. Yuba ranked fourth among the counties in both years in total value of output.

Brownsville district.—The Wallberg Mining Corporation, operating the Golden Hope lode mine at Challenge, made the only sizable output of gold in the Brownsville district in 1934.

Dobbins district.—In the Dobbins district the Stanfield Hill placer was sold by Stanfield Gold Mines in April 1934 to the Sierra Gold Dredging Co., which operated it with a 6-cubic foot dredge and made the largest output of gold in the district during the year. At the Red Cross mine 31 miles northeast of Marysville, operated at intervals from January to May, 279 tons of ore treated in a 15-ton cyanide plant yielded 51 ounces of gold and 2 ounces of silver; the ore was crushed to 16-mesh in a 2-stamp mill with the cyanide solution introduced at the stamps.

Smartsville district.—At the Blue Point drift mine, the largest gold producer in the Smartsville district in 1934, 4,357 cubic yards of cemented gravel were mined and washed. The next largest output came from the Anderson Ranch mine 12 miles north of Lincoln.

The ore (160 tons) was treated in the Queen Lil custom mill by amalgamation and concentration, and 2 tons of concentrates were produced and shipped to the Selby smelter; the total recovery was 62 ounces of gold and 40 ounces of silver.

Yuba River district.—The Yuba River district was one of the largest gold-producing districts in the State in 1934; the entire yield came from placers. The Yuba Consolidated Gold Fields, operating five electric dredges throughout the year in the Yuba River Basin near Hammonton, was the outstanding producer; 17,055,649 cubic yards of gravel were handled. These five dredges are of all-steel construction and have 16½-cubic foot buckets. The Yuba No. 17, built in 1934, is the largest gold dredge in the world and can dig 110 feet below water level; a bucket idler mounted beneath the center of the bucket ladder supports the bucket line, which weighs about 300 tons.

Other districts.—The Camptonville, Honcut Creek, and Strawberry Valley districts produced a total of 848 ounces of gold and 133 ounces of silver in 1934 from various small lode and placer mines.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO

(MINE REPORT)

By Chas. W. Henderson

SUMMARY OUTLINE

The total output of gold, silver, copper, lead, and zinc from Colorado ores and gravels in 1934, in terms of recovered and estimated recoverable metals, was 324,923.32 fine ounces of gold, 3,475,661 fine ounces of silver, 11,294,000 pounds of copper, 8,435,000 pounds of lead, and 1,544,000 pounds of zinc. This output compares with a production in 1933 of 242,827.70 ounces of gold, 2,186,140 ounces of silver, 9,667,000 pounds of copper, 4,803,000 pounds of lead, and 2,569,000 pounds of zinc. There were 929 lode mines and 967 placers producing in 1934, an increase of 315 lode mines and 681 placers from 1933.

The total recorded output from Colorado ores and gravels from 1858 to 1934, inclusive, all in terms of recovered metals, has been 35,730,277 ounces of gold, 667,650,042 ounces of silver, 341,764,430 pounds of copper, 4,624,877,583 pounds of lead, and 2,234,456,985 pounds of zinc.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly United States Government prices.[1] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, copper, lead, and zinc in Colorado, 1930–34, in terms of recovered metals

Year	Mines producing			Ore sold or treated (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total		Fine ounces	Value	Fine ounces	Value
1930	313	21	334	1,335,731	218,539.82	$4,517,619	4,382,852	$1,687,398
1931	340	195	535	1,036,562	233,299.75	4,822,734	2,195,914	636,815
1932	478	335	813	935,895	317,927.95	6,572,154	1,860,408	5[illegible]4,635
1933	614	286	900	8[illegible]5,495	242,827.70	[1] 6,206,676	2,186,140	765,149
1934	929	967	1,896	1,309,187	324,923.32	11,356,070	3,475,661	2,246,892

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1930	10,514,000	$1,366,820	44,260,000	$2,213,000	72,518,000	$3,480,864	$13,265,701
1931	8,165,000	743,015	13,768,000	509,416	32,373,000	1,230,174	7,942,154
1932	7,398,000	466,074	4,299,000	128,970	218,000	6,540	7,698,373
1933	9,667,000	618,688	4,803,000	177,711	2,569,000	107,898	[1] 7,876,122
1934	11,294,000	903,520	8,435,000	312,0[illegible]5	1,544,000	66,392	14,884,969

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold and silver produced at placer mines in Colorado, 1930–34, in fine ounces, in terms of recovered metals

Year	Sluicing and hydraulic		Dry-land dredges [1]		Floating dredges		Total	
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
1930	[2] 358.90	[2] 57	(2)	(2)	6,328.61	1,600	6,687.51	1,657
1931	[2] 777.32	[2] 121	(2)	(2)	266.90	69	1,044.22	190
1932	[2] 1,376.79	[2] 283	(2)	(2)	1,122.02	288	2,498.81	571
1933	2,046.85	480	464.70	69	2,813.96	711	5,325.51	1,260
1934	4,086.39	855	3,594.34	533	7,292.26	1,828	14,972.99	3,216

[1] Drag-line and power-shovel excavators with sluices or special amalgamators.
[2] Figures for sluicing and hydraulic include those for dry-land dredges.

[1] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934 pp. 25–28.

Gold.—The production of gold in Colorado in 1934, in terms of recovered metal, was 324,923.32 fine ounces, an increase from 1933 of 82,095.62 ounces. In 1934 the Cripple Creek district contributed 127,949.90 ounces (39.38 percent of the State total). Park County yielded 85,867.64 ounces (26.43 percent); Boulder, 17,536.48 ounces (5.40 percent); San Juan, 16,591.99 ounces (5.11 percent); Lake, 15,173.19 ounces (4.67 percent); Clear Creek, 11,901.23 ounces (3.66 percent); and Ouray, 8,159.17 ounces (2.51 percent). The largest increases in quantity were 25,721.31 ounces in Park County, 18,081.52 ounces in Teller, and 13,133.97 ounces in Boulder. The largest decrease was 6,881.88 ounces in San Juan County.

Placer mines yielded 14,972.99 fine ounces of gold in 1934, an increase of 9,647.48 ounces over 1933. Summit County produced 7,665.75 ounces, principally from the operation of two dredges on Blue River in the Breckenridge district. Jefferson County produced 2,562.12 ounces, mainly from the operation of a traction dry-land dredge on Clear Creek near the Jefferson-Clear Creek-Gilpin County lines. Park, Gilpin, Lake, and Montrose Counties followed in importance in output from placers. A group of adjoining counties, including Adams, Arapahoe, Denver, Douglas, and Elbert, lying out on the plains just east of the mountains, produced 317.56 ounces from numerous small individual sluicing and panning operations. The other counties producing placer gold in 1934 were Boulder, Chaffee, Clear Creek, Costilla, Delta, Dolores, Eagle, Fremont, Grand, Gunnison, Huerfano, Jackson, La Plata, Mesa, Moffat, Montezuma, Ouray, Routt, San Juan, San Miguel, and Teller.

Silver.—The production of silver in Colorado in 1934, in terms of recovered metal, was 3,475,661 fine ounces valued at $2,246,892, an increase of 1,289,521 ounces in quantity and $1,481,743 in value from 1933, after an increase of 325,732 ounces in quantity and $240,514 in value from 1932 to 1933. In 1934 Eagle County produced 1,942,284 ounces (55.88 percent of the State total); Mineral, 479,890 ounces (13.81 percent); San Juan, 303,012 ounces (8.72 percent); Pitkin, 121,105 ounces (3.48 percent); and Ouray, 109,853 ounces (3.16 percent). The largest increases were 479,890 ounces in Mineral County which had no production in 1933, 458,141 ounces in Eagle, 69,238 ounces in Clear Creek, 56,530 ounces in Ouray, 52,245 ounces in Pitkin, and 50,749 ounces in Lake. Among the important producing counties the only decrease was 86,630 ounces in San Juan County.

Copper.—The production of recoverable copper in Colorado in 1934 was 11,294,000 pounds valued at $903,520, an increase of 1,627,000 pounds in quantity and $284,832 in value from 1933. Eagle County produced 9,819,000 pounds, or 86.94 percent of the State total; next in order were San Juan (819,300 pounds), Ouray (211,700 pounds), San Miguel (112,200 pounds), Lake (90,400 pounds), and Clear Creek (77,500 pounds). The largest increases were 1,656,000 pounds in Eagle County, 84,200 pounds in San Miguel, 75,400 pounds in Lake, 66,500 pounds in Clear Creek, and 50,200 pounds in Ouray. The only decrease among the largest producing counties was 364,700 pounds in San Juan County.

Lead.—The production of recoverable lead in Colorado in 1934, reckoned as lead in lead bullion and in leaded zinc oxide, was 8,435,000 pounds valued at $312,095, an increase of 3,632,000 pounds in quantity and $134,384 in value from 1933. In 1934 Park, San Juan, and

Lake Counties each produced more than 1,000,000 pounds; the other more important producing counties were Clear Creek (455,000 pounds), Ouray (431,000 pounds), Pitkin (411,000 pounds), and San Miguel (393,000 pounds). Dry and siliceous ores yielded 6,690,250 pounds of lead, lead ore 1,174,200 pounds, and lead-zinc ore 402,450 pounds; a small output came from copper and copper-lead ores.

Zinc.—The zinc-bearing ores marketed from Colorado in 1934 contained 1,544,000 pounds of recoverable zinc valued at $66,392, a decrease of 1,025,000 pounds in quantity and $41,506 in value from 1933. Lead-zinc sulphide ore shipped from Lake County to the pigment plant at Coffeyville, Kans., contained most of the zinc recovered from ores mined in the State in 1934; the remainder was produced from zinc concentrates (a byproduct of dry silver ore from Pitkin County) shipped to Amarillo, Tex., and from lead-zinc ores shipped from Dolores, Gunnison, San Juan, and San Miguel Counties to reduction plants in Utah.

MINE PRODUCTION BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1934, by counties, in terms of recovered metals

County	Mines producing			Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total	Fine ounces	Value	Fine ounces	Value
Adams		16	16	19.54	$683	2	$1
Alamosa	2		2	4.35	152		
Arapahoe		42	42	59.57	2,082	2	1
Boulder	217	20	237	17,536.48	612,900	57,171	36,959
Chaffee	18	45	63	1,597.94	55,848	7,886	5,098
Clear Creek	153	84	237	11,901.23	415,948	97,444	62,994
Costilla		2	2	8.70	304		
Custer	6		6	19.14	669	4,571	2,955
Delta		8	8	31.96	1,117	5	3
Denver		115	115	124.29	4,344	4	3
Dolores	7	1	8	351.56	12,287	49,302	31,872
Douglas		72	72	104.26	3,644		
Eagle	14	8	22	6,967.64	243,519	1,942,284	1,255,618
Elbert		1	1	9.90	346		
Fremont		13	13	60.77	2,124	12	8
Gilpin	135	147	282	7,748.41	270,807	35,080	22,678
Grand	1	9	10	11.59	405	427	276
Gunnison	29	17	46	2,642.69	92,362	10,641	6,879
Hinsdale	1		1	.23	8	577	373
Huerfano		3	3	2.72	95		
Jackson		3	3	9.33	326		
Jefferson		48	48	2,562.12	89,546	388	251
Lake	52	35	87	15,173.19	530,303	86,738	56,073
La Plata	13	1	14	2,537.11	88,672	16,748	10,827
Larimer	6		6	42.86	1,498	1,239	801
Las Animas	1		1			48	31
Mesa	1	5	6	15.02	525	164	106
Mineral	7		7	55.00	1,922	479,890	310,232
Moffat		8	8	68.67	2,400	4	3
Montezuma	3	3	6	791.76	27,672	775	501
Montrose		45	45	246.35	8,610	78	50
Ouray	11	11	22	8,159.17	285,163	109,853	71,016
Park	40	45	85	85,867.64	3,001,074	61,510	39,764
Pitkin	6		6	13.90	486	121,105	78,290
Rio Grande	2		2	1,201.06	41,977	2,393	1,547
Routt	1	20	21	48.87	1,708	99	64
Saguache	8		8	49.50	1,730	215	139
San Juan	16	3	19	16,591.99	579,890	303,012	195,887
San Miguel	36	30	66	6,272.99	219,241	66,938	43,273
Summit	18	97	115	8,063.92	281,834	6,500	4,202
Teller	125	10	135	127,949.90	4,471,849	12,556	8,117
	929	967	1,896	324,923.32	11,356,070	3,475,661	2,246,892
Total, 1933	614	286	900	242,827.70	[1] 6,206,676	2,186,140	765,149

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1934, by counties, in terms of recovered metals—Continued

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Adams							$684
Alamosa							152
Arapahoe							2,083
Boulder	21,400	$1,712	69,000	$2,553			654,124
Chaffee	2,700	216	80,000	2,960			64,122
Clear Creek	77,500	6,200	455,000	16,835			501,977
Costilla							304
Custer	1,300	104	23,000	851			4,579
Delta							1,120
Denver							4,347
Dolores	19,800	1,584	239,000	8,843	214,000	$9,202	63,788
Douglas							3,644
Eagle	9,819,000	785,520	104,400	3,863			2,288,520
Elbert							346
Fremont							2,132
Gilpin	32,600	2,608	165,000	6,105			302,198
Grand							681
Gunnison	500	40	58,000	2,146	33,000	1,419	102,846
Hinsdale			500	18			399
Huerfano							95
Jackson							326
Jefferson							89,797
Lake	90,400	7,232	1,049,500	38,832	1,029,000	44,247	676,687
La Plata			7,900	292			99,791
Larimer							2,299
Las Animas			700	26			57
Mesa	5,000	400					1,031
Mineral			176,900	6,545			318,699
Moffat							2,403
Montezuma	600	48					28,221
Montrose							8,660
Ouray	211,700	16,936	431,000	15,947			389,062
Park	72,100	5,768	2,625,800	97,155			3,143,761
Pitkin	900	72	411,000	15,207	233,000	10,019	104,074
Rio Grande	6,000	480					44,004
Routt							1,772
Saguache	300	24	2,000	74			1,967
San Juan	819,300	65,544	2,051,000	75,887	2,000	86	917,294
San Miguel	112,200	8,976	393,000	14,541	33,000	1,419	287,450
Summit	700	56	92,300	3,415			289,507
Teller							4,479,966
	11,294,000	903,520	8,435,000	312,095	1,544,000	66,392	14,884,969
Total, 1933	9,667,000	618,688	4,803,000	177,711	2,569,000	107,898	[1]7,876,122

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold and silver produced at lode mines in Colorado in 1934, by counties, in terms of recovered metals

County	Ore sold or treated	Gold	Silver
	Short tons	*Fine ounces*	*Fine ounces*
Alamosa	8	4.35	----------
Boulder	55,715	17,425.58	57,162
Chaffee	1,282	1,449.10	7,860
Clear Creek	63,241	11,717.77	97,425
Custer	182	19.14	4,571
Dolores	930	340.60	49,300
Eagle	135,650	6,896.05	1,942,270
Gilpin	113,262	7,180.63	34,904
Grand	5	.40	426
Gunnison	9,554	2,548.01	10,616
Hinsdale	7	.23	577
Lake	28,791	14,648.61	86,629
La Plata	13,712	2,534.39	16,748
Larimer	32	42.86	1,239
Las Animas	3	----------	48
Mesa	18	----------	163
Mineral	5,907	55.00	479,890
Montezuma	718	783.98	775
Ouray	32,462	8,116.74	109,839
Park	128,977	83,910.47	61,214
Pitkin	9,798	13.90	121,105
Rio Grande	5,702	1,201.06	2,393
Routt	2	2.26	76
Saguache	126	49.50	215
San Juan	210,489	16,571.53	303,006
San Miguel	66,536	6,138.80	66,868
Summit	836	398.17	4,571
Teller	425,242	127,901.20	12,555
	1,309,187	309,950.33	3,472,445
Total, 1933	845,495	237,502.19	2,184,880

Gold and silver produced at placer mines in Colorado in 1934, by counties, in fine ounces, in terms of recovered metals

County	Sluicing and hydraulic		Dry-land dredges [1]		Floating dredges		Total	
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
Adams	19.54	2	--------	--------	--------	--------	19.54	2
Arapahoe	59.57	2	--------	--------	--------	--------	59.57	2
Boulder	92.10	7	18.80	2	--------	--------	110.90	9
Chaffee	148.84	26	--------	--------	--------	--------	148.84	26
Clear Creek	154.62	17	28.84	2	--------	--------	183.46	19
Costilla	8.70	--------	--------	--------	--------	--------	8.70	--------
Delta	31.96	5	--------	--------	--------	--------	31.96	5
Denver	124.29	4	--------	--------	--------	--------	124.29	4
Dolores	10.96	2	--------	--------	--------	--------	10.96	2
Douglas	104.26	--------	--------	--------	--------	--------	104.26	--------
Eagle	13.27	3	58.32	11	--------	--------	71.59	14
Elbert	9.90	--------	--------	--------	--------	--------	9.90	--------
Fremont	60.77	12	--------	--------	--------	--------	60.77	12
Gilpin	523.58	173	44.20	3	--------	--------	567.78	176
Grand	11.19	1	--------	--------	--------	--------	11.19	1
Gunnison	94.68	25	--------	--------	--------	--------	94.68	25
Huerfano	2.72	--------	--------	--------	--------	--------	2.72	--------
Jackson	9.33	--------	--------	--------	--------	--------	9.33	--------
Jefferson	82.38	17	2,479.74	371	--------	--------	2,562.12	388
Lake	282.38	33	242.20	76	--------	--------	524.58	109
La Plata	2.72	--------	--------	--------	--------	--------	2.72	--------
Mesa	15.02	1	--------	--------	--------	--------	15.02	1
Moffat	68.67	4	--------	--------	--------	--------	68.67	4
Montezuma	7.78	--------	--------	--------	--------	--------	7.78	--------
Montrose	191.91	61	54.44	17	--------	--------	246.35	78
Ouray	42.43	14	--------	--------	--------	--------	42.43	14
Park	1,305.74	248	651.43	48	--------	--------	1,957.17	296
Routt	46.61	23	--------	--------	--------	--------	46.61	23
San Juan	20.46	6	--------	--------	--------	--------	20.46	6
San Miguel	134.19	70	--------	--------	--------	--------	134.19	70
Summit	357.12	98	16.37	3	7,292.26	1,828	7,665.75	1,929
Teller	48.70	1	--------	--------	--------	--------	48.70	1
	4,086.39	855	3,594.34	533	7,292.26	1,828	14,972.99	3,216
Total, 1933	2,046.85	480	464.70	69	2,813.96	711	5,325.51	1,260

[1] Drag-line and power-shovel excavators with sluices or special amalgamators.

MINING INDUSTRY

The total ore, old tailings, and other lode material sold or treated in Colorado was 1,309,187 tons in 1934 compared with 845,495 tons in 1933. It is impossible to get a total for quantity of gravel treated because of lack of actual knowledge by the operator of the quantity of gravel sluiced. Yardage of gravel handled by machines, as given in reports of some of the individual operations, is recorded in the following district reviews. Each of the principal metal-producing counties in the State, except Saguache, contributed in some degree to the important general increase in total mine output. The largest increases in tonnage handled were in dry and siliceous gold, gold-silver, and silver ores from Teller, Park, Gilpin, Boulder, Clear Creek, San Miguel, Ouray, San Juan, and Mineral Counties, named in order of increase, and in base-metal ores (with which are associated important quantities of gold and silver) from Eagle County. The largest gains in output of placer gold were made in Jefferson, Park, and Summit Counties by floating dredges and various forms of machine excavators. Operating details in these and other counties and districts of the State are given in the following review by counties and districts.

ORE CLASSIFICATION

Ore sold or treated in Colorado in 1934, with content in terms of recovered metals

Source	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous gold ore	924,273	284,233.48	408,079	596,700	4,204,300	
Dry and siliceous gold and silver ore	212,607	16,886.58	313,243	802,250	1,739,000	
Dry and siliceous silver ore	27,695	111.43	714,030	9,800	746,950	233,000
	1,164,575	301,231.49	1,435,352	1,408,750	6,690,250	233,000
Copper ore	135,082	5,582.37	1,927,335	9,834,150	111,200	
Copper-lead ore	201	183.76	2,309	11,600	56,900	
Lead ore	5,677	2,582.81	70,352	16,800	1,174,200	
Lead-zinc ore	3,652	369.90	37,097	22,700	402,450	1,311,000
	144,612	8,718.84	2,037,093	9,885,250	1,744,750	1,311,000
Total, lode mines	1,309,187	309,950.33	3,472,445	11,294,000	8,435,000	1,544,000
Total, placers		14,972.99	3,216			
	1,309,187	324,923.32	3,475,661	11,294,000	8,435,000	1,544,000
Total, 1933	845,495	242,827.70	2,186,140	9,667,000	4,803,000	2,569,000

METALLURGIC INDUSTRY

Custom reduction plants operating in Colorado in 1934 were: The lead bullion-leady copper matte smelter at Leadville; the Golden Cycle roast-amalgamation-cyanidation-flotation mill at Colorado Springs; the St. Joe flotation mill in Left Hand Canyon, the McAnally Mining Co. mill at Salina, the Nancy mill in the Sugar Loaf district, and the sampling plant at Boulder, Boulder County; the Clear Creek-Gilpin Co. sampler and mill at Idaho Springs, the Watrous flotation mill at Silver Plume, and the Dumont amalgamation-gravity concentration-flotation mill at Dumont, Clear Creek County; the Chain O'Mines amalgamation-gravity concentration-selective flotation mill, the Farr-Western mill, and the Polar Star mill, Gilpin County; and the Smuggler-Union mill at Pandora, San Miguel County. Ores were shipped to custom plants in other States as follows: Zinc-lead sulphide ore from Lake County to Coffeyville, Kans.; iron-copper-silver-gold ore from Eagle County and small lots of gold ore from the San Juan region to Utah smelters; and zinc-lead-silver ore from Dolores, Gunnison, and San Miguel Counties to the selective flotation mill at Midvale, Utah.

Details of plants other than custom plants are given under the district reviews. Details of treatment of the total ore produced in the State in 1934 are shown in the following tables.

Mine production of metals in Colorado in 1934, by methods of recovery, in terms of recovered metals

Method of recovery	Material treated	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Ore amalgamated	571,974	52,180.18	38,324			
Ore, concentrates, sands, and slimes cyanided	468,955	115,245.18	56,953			
Concentrates smelted	38,604	113,811.71	701,041	1,295,300	5,958,850	233,000
Ore smelted	173,066	28,713.26	2,676,127	9,998,700	2,476,150	1,311,000
Placer		14,972.99	3,216			
		324,923.32	3,475,661	11,294,000	8,435,000	1,544,000
Total, 1933		242,827.70	2,186,140	9,667,000	4,803,000	2,569,000

Ore treated by amalgamation, ore, concentrates, sands, and slimes treated by cyanidation, and gold and silver contained in bullion and precipitates in Colorado in 1934

Process	Material treated	Gold in bullion	Silver in bullion	Quicksilver purchased	Sodium cyanide used
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Amalgamation	571,974	52,180.18	38,324	1,629	
Cyanidation	[1] 468,955	115,245.18	56,953		[2] 407,471

[1] Includes 355,841 tons of sands and slimes from ore and concentrates known to have been first amalgamated, 110,004 tons of estimated tailings from ore first floated and other sands and slimes from iron concentrates first amalgamated, and 3,110 tons of crude ore cyanided.

[2] Reduced to equivalent of 96- to 98-percent strength. Actually 814,941 pounds of cyanamid of approximately 48- to 49-percent strength.

Mine production of metals from gold and silver mills in Colorado in 1934, by counties, in terms of recovered metals

County	Ore treated	Recovered in bullion		Concentrates and recovered metal				
		Gold	Silver	Concentrates produced	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Alamosa	8	4.35						
Boulder	40,568	13,742.21	17,827	5	59.00	78		6,000
Chaffee	931	630.95	4,236	60	720.00	2,400		53,500
Clear Creek	25,981	2,305.53	12,433	1,713	2,369.99	23,975	24,400	109,500
Custer	29	17.61	691					
Eagle	147	466.49	1,241					
Gilpin	110,259	3,352.57	7,229	2,207	2,244.15	12,624	16,300	80,600
Grand	5	.40	426					
Gunnison	9,231	2,197.89	1,529	141	187.07	2,861	50	10,300
Lake	6,457	2,118.63	7,684					
La Plata	110	171.59	79					
Larimer	29	38.78	64					
Mineral	618		23,636					
Montezuma	174	594.34	387					
Ouray	21,495	4,873.80	1,554	1,853	2,567.82	58,780	204,000	318,000
Park	13,878	6,884.13	1,825	536	938.46	4,289	19,000	1,300
Pitkin		2.70						
Rio Grande	5,702	39.58		297	1,161.48	2,393	6,000	
Routt	2	2.26	76					
Saguache	115	24.91	11	3	22.70	56	300	1,000
San Juan	5	84.96	25					
San Miguel	17,139	1,911.16	1,640	1,097	1,382.94	30,741	300	264,800
Summit	62	59.32	129					
Teller	425,242	127,901.20	12,555					
	678,187	167,425.36	95,277	7,912	11,653.61	138,197	270,350	845,000
Total, 1933	458,978	140,701.68	32,935	4,558	16,128.02	87,679	223,400	876,061

Mine production of metals from concentrating mills in Colorado in 1934, by counties, in terms of recovered metals

County	Ore treated	Concentrates and recovered metal					
		Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Boulder	15,024	1,549	3,465.69	14,072	19,900	61,000	
Chaffee	200	5	12.72	59	100	400	
Clear Creek	36,322	3,683	6,302.86	38,929	45,150	234,000	
Gilpin	2,243	426	757.02	5,829	2,100	50,500	
La Plata	13,323	246	1,373.00	12,302		2,100	
Montezuma	500	82	31.24	3			
Ouray	10,447	152	19.54	46,608	2,700	107,500	
Park	112,779	14,906	72,309.90	48,031	51,900	2,503,700	
Pitkin	9,000	736		95,919	900	391,000	233,000
San Juan	209,703	8,102	15,969.00	278,288	802,200	1,726,000	
San Miguel	48,393	805	1,917.13	22,804	100,000	37,650	
	457,934	30,692	102,158.10	562,844	1,024,950	5,113,850	233,000
Total, 1933	273,978	15,022	58,649.20	498,363	1,232,840	2,465,282	77,000

Gross metal content of concentrates produced from ores mined in Colorado in 1934, by classes of concentrates

Class of concentrates	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper (wet assay)	Lead (wet assay)	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold	10,022	17,884.85	87,715	140,237	325,187	336,154
Dry silver	3	.13	751		28	2,029
Copper	852	1,997.85	23,109	116,898	53,298	96,897
Copper-lead	10,317	24,881.82	342,107	1,291,556	2,510,717	2,268,616
Lead	17,107	69,049.22	236,643	54,663	3,831,649	1,495,655
Zinc	303		10,813	1,379	31,957	280,595
	38,604	113,813.87	701,138	1,604,733	6,752,836	4,479,946
Total, 1933	19,580	74,777.25	586,171	1,818,546	3,705,288	2,671,566

Mine production of metals from Colorado concentrates in 1934, in terms of recovered metals

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Boulder	1,554	3,524.69	14,150	19,900	67,000	
Chaffee	65	732.72	2,459	100	53,900	
Clear Creek	5,396	8,672.85	62,904	69,550	343,500	
Gilpin	2,633	3,001.17	18,453	18,400	131,100	
Gunnison	141	187.07	2,861	50	10,300	
La Plata	246	1,373.00	12,302		2,100	
Montezuma	82	31.24	3			
Ouray	2,005	2,587.36	105,388	206,700	425,500	
Park	15,442	73,248.36	52,320	70,900	2,505,000	
Pitkin	736		95,919	900	391,000	233,000
Rio Grande	297	1,161.48	2,393	6,000		
Saguache	3	22.70	56	300	1,000	
San Juan	8,102	15,969.00	278,288	802,200	1,726,000	
San Miguel	1,902	3,300.07	53,545	100,300	302,450	
	38,604	113,811.71	701,041	1,295,300	5,958,850	233,000
Total, 1933	19,580	74,777.22	586,042	1,456,240	3,341,343	77,000

BY CLASSES OF CONCENTRATES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
Dry gold	10,022	17,882.91	87,692	112,550	292,950	
Dry silver	3	.13	751			
Copper	852	1,997.85	23,109	104,800	37,650	
Copper-lead	10,317	24,881.82	342,107	1,033,350	2,180,000	
Lead	17,107	69,049.00	236,569	43,700	3,419,250	
Zinc	303		10,813	900	29,000	233,000
	38,604	113,811.71	701,041	1,295,300	5,958,850	233,000

Gross metal content of Colorado crude ore shipped to smelters in 1934, by classes of ore

Class of ore	Ore		Gross metal content				
			Gold	Silver	Copper	Lead	Zinc
	Short tons	*Percent*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold	21,889	12.65	19,493.52	90,143	136,144	661,834	25,729
Dry gold and silver	666	.39	577.15	24,065	67	5,783	2,358
Dry silver	6,340	3.66	27.75	527,588	3,893	208,908	23,509
Copper	135,082	78.05	5,582.37	1,927,340	10,245,949	215,210	2,701,708
Copper-lead	194	.11	183.23	2,207	14,216	62,410	---
Lead	5,243	3.03	2,479.46	67,703	21,652	1,245,802	67,018
Lead-zinc	3,652	2.11	374.12	37,151	28,299	494,347	1,634,929
	173,066	100.00	28,717.61	2,676,197	10,450,220	2,894,294	4,455,251
Total, 1933	112,539	100.00	22,023.43	1,565,916	8,561,587	1,859,420	4,946,331

Mine production of metals from Colorado crude ore shipped to smelters in 1934, in terms of recovered metals

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Boulder	123	158.68	25,185	1,500	2,000	---
Chaffee	151	85.43	1,165	2,600	26,100	---
Clear Creek	938	739.39	22,088	7,950	111,500	---
Custer	153	1.53	3,880	1,300	23,000	---
Dolores	930	340.60	49,300	19,800	239,000	214,000
Eagle	135,503	6,429.56	1,941,029	9,819,000	104,400	---
Gilpin	760	826.89	9,222	14,200	33,900	---
Gunnison	323	163.05	6,226	450	47,700	33,000
Hinsdale	7	.23	577	---	500	---
Lake	22,334	12,529.98	78,945	90,400	1,049,500	1,029,000
La Plata	279	989.80	4,367	---	5,800	---
Larimer	3	4.08	1,175	---	---	---
Las Animas	3	---	48	---	700	---
Mesa	18	---	163	5,000	---	---
Mineral	5,289	55.00	456,254	---	176,900	---
Montezuma	44	158.40	385	600	---	---
Ouray	520	655.58	2,897	5,000	5,500	---
Park	2,320	3,777.98	7,069	1,200	120,800	---
Pitkin	798	11.20	25,186	---	20,000	---
Saguache	11	1.89	148	---	1,000	---
San Juan	781	517.57	24,693	17,100	325,000	2,000
San Miguel	1,004	927.57	11,683	11,900	90,500	33,000
Summit	774	338.85	4,442	700	92,300	---
	173,066	28,713.26	2,676,127	9,998,700	2,476,150	1,311,000
Total, 1933	112,539	22,023.29	1,565,903	8,210,760	1,461,657	2,492,000

BY CLASSES OF ORE

	Ore	Gold	Silver	Copper	Lead	Zinc
Dry gold	21,889	19,493.52	90,143	110,500	595,750	---
Dry gold and silver	666	577.15	24,061	50	5,100	---
Dry silver	6,340	27.68	527,588	3,100	187,350	---
Copper	135,082	5,582.37	1,927,335	9,834,150	111,200	---
Copper-lead	194	183.23	2,207	11,400	56,200	---
Lead	5,243	2,479.41	67,696	16,800	1,118,100	---
Total to copper and lead plants	169,414	28,343.36	2,639,030	9,976,000	2,073,700	---
Lead-zinc	3,652	369.90	37,097	22,700	402,450	1,311,000
	173,066	28,713.26	2,676,127	9,998,700	2,476,150	1,311,000

REVIEW BY COUNTIES AND DISTRICTS

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1934, by counties and districts, in terms of recovered metals

County and district	Number of mines producing		Ore sold or treated	Gold			Silver			Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total	Lode	Placer	Total				
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Adams County		16			19.54	19.54		2	2				$684
Alamosa County	2		8	4.35		4.35							152
Arapahoe County		42			59.57	59.57		2	2				2,083
Boulder County:													
Central	27	4	5,832	2,999.97	5.80	3,005.77	28,221		28,221				123,296
Gold Hill	78	4	24,657	6,370.93	5.40	6,376.33	17,458		17,458	17,200	60,100		237,739
Grand Island	17	11	862	920.80	80.90	1,001.70	6,056	7	6,063		8,000		39,225
Magnolia	18		828	354.19		354.19	31		31				12,399
Sugar Loaf	46	1	19,247	6,025.24	18.80	6,044.04	4,429	2	4,431				214,103
Ward	31		4,289	754.45		754.45	967		967	4,200	900		27,362
Chaffee County:													
Arkansas River		11			10.98	10.98		3	3				386
Chalk Creek	2		1,113	1,274.74		1,274.74	7,512		7,512	100	59,300		51,610
Four Mile	1		9	8.70		8.70							304
Granite [1]	6	34	68	125.98	137.86	263.84	31	23	54		2,500		9,349
Monarch	1		28	.20		.20	288		288	900	18,000		931
Riverside	4		44	9.30		9.30	23		23	1,700	200		483
Trout Creek	1		5	9.81		9.81							343
Turret	3		15	20.37		20.37	6		6				716
Clear Creek County:													
Alice	5		374	127.81		127.81	79		79				4,518
Argentine	3		1,137	125.00		125.00	2,331		2,331	3,400	24,700		7,062
Empire	18	3	9,913	1,659.92	1.26	1,661.18	507		507	700	1,600		58,501
Griffith	13		2,863	577.80		577.80	10,901		10,901	2,600	61,400		29,721
Idaho Springs	89	81	43,162	8,302.89	182.20	8,485.09	55,895	19	55,914	58,300	276,100		347,580
Montana	19		2,858	286.87		286.87	24,521		24,521	8,000	86,600		29,722
Trail Creek	6		2,934	637.48		637.48	3,191		3,191	4,500	4,600		24,873
Costilla County: Grayback		2			8.70	8.70							304
Custer County:													
Hardscrabble	5		170	6.01		6.01	4,534		4,534	1,300	23,000		4,096
Rosita Hills	1		12	13.13		13.13	37		37				483
Delta County		8			31.96	31.96		5	5				1,120
Denver County		115			124.29	124.29		4	4				4,347
Dolores County: Pioneer	7	1	930	340.60	10.96	351.56	49,300	2	49,302	19,800	239,000	214,000	63,788
Douglas County		72			104.26	104.26							3,644

Eagle County:													
Burns		8			71.59	71.59		14	14				2,511
Red Cliff	14		135,650	6,896.05		6,896.05	1,942,270		1,942,270	9,819,000	104,400		2,286,009
Elbert County		1			9.90	9.90							346
Fremont County: Arkansas River		13			60.77	60.77		12	12				2,132
Gilpin County:													
Southern	119	102	112,353	6,825.83	447.12	7,272.95	34,762	162	34,924	32,600	165,000		285,480
Northern	16	45	909	354.80	120.66	475.46	142	14	156				16,718
Grand County	1	9	5	.40	11.19	11.59	426	1	427				681
Gunnison County:													
Cochetopa	3		210	116.62		116.62	8		8				4,081
Domingo	4		47	39.77		39.77	34		34				1,412
Elk Mountain	4	2	61	5.44	6.18	11.62	1,623	3	1,626		2,350		1,544
Gold Brick	10		8,618	2,239.09		2,239.09	5,012		5,012	150	22,450		82,339
Quartz Creek	3		466	137.28		137.28	575		575	50	1,550		5,231
Rock Creek	2		65	2.86		2.86	2,286		2,286		200		1,585
Taylor Park (Tin Cup)	2	15	8	6.55	88.50	95.05	14	22	36				3,345
Tomichi	1		79	.40		.40	1,064		1,064	300	31,450	33,000	3,309
Hinsdale County: Galena	1		7	.23		.23	577		577		500		399
Huerfano County		3			2.72	2.72							95
Jackson County		3			9.33	9.33							326
Jefferson County		48			2,562.12	2,562.12		388	388				89,797
Lake County:													
California (Leadville)	42	32	28,433	14,282.09	293.36	14,575.45	83,573	36	83,609	90,400	1,047,800	1,029,000	653,710
Granite [1]	2	2	44	84.72	7.27	91.99	6		6				3,219
St. Kevin	2		264	81.91		81.91	2,911		2,911		400		4,760
Twin Lakes	6	1	50	199.89	223.95	423.84	139	73	212		1,300		14,998
La Plata County:													
California	10	1	13,663	2,454.85	2.72	2,457.57	16,748		16,748		7,900		97,011
Needle Mountain	3		49	79.54		79.54							2,780
Larimer County	6		32	42.86		42.86	1,239		1,239				2,299
Las Animas County	1		3				48		48		700		57
Mesa County	1	5	18		15.02	15.02	163	1	164	5,000			1,031
Mineral County	7		5,907	55.00		55.00	479,890		479,890		176,900		318,699
Moffat County:													
Fourmile (Timberlake)		6			54.65	54.65		3	3				1,912
Lay		1			11.82	11.82		1	1				414
Round Bottom		1			2.20	2.20							77
Montezuma County	3	3	718	783.98	7.78	791.76	775		775	600			28,221
Montrose County:													
La Sal		5			55.76	55.76		11	11				1,956
Naturita		40			190.59	190.59		67	67				6,704
Ouray County:													
Ridgway		11			42.43	42.43		14	14				1,492
Sneffels	5		21,567	7,497.83		7,497.83	60,695		60,695	204,000	319,650		329,433
Uncompahgre	6		10,895	618.91		618.91	49,144		49,144	7,700	111,350		58,137
Park County:													
Alma Placers		1			1,046.04	1,046.04		208	208				36,693
Beaver Creek		8			21.51	21.51		3	3				754
Buckskin	5	6	8,924	1,178.17	7.87	1,186.04	5,052		5,052	19,100	100		46,250

[1] Granite district lies in both Chaffee and Lake Counties.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1934, by counties and districts, in terms of recovered metals—Continued

County and district	Number of mines producing		Ore sold or treated	Gold			Silver			Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total	Lode	Placer	Total				
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Park County—Continued.													
Consolidated Montgomery	8	1	93	64. 21	1. 80	66. 01	2, 337		2, 337	500	6, 500		$4, 099
Fairplay		8			142. 09	142. 09		28	28				4, 984
Hall Valley	1		9	. 91		. 91	127		127				114
Mosquito	24	1	119, 932	82, 657. 71	. 69	82, 658. 40	53, 698		53, 698	52, 500	2, 619, 200		3, 024, 735
Tarryall	2	20	19	9. 47	737. 17	746. 64		57	57				26, 132
Pitkin County:													
Independence	1		14	13. 90		13. 90	11		11				493
Roaring Fork	5		9, 784				121, 094		121, 094	900	411, 000	233, 000	103, 581
Rio Grande County: Summitville	2		5, 702	1, 201. 06		1, 201. 06	2, 393		2, 393	6, 000			44, 004
Routt County: Hahns Peak	1	20	2	2. 26	46. 61	48. 87	76	23	99				1, 772
Saguache County:													
Blake and Music [2]	2		111	41. 20		41. 20	65		65	300	1, 000		1, 543
Crestone	1		3	1. 78		1. 78	1		1				63
Kerber Creek	3		8	. 11		. 11	147		147		1, 000		136
Vulcan	2		4	6. 41		6. 41	2		2				225
San Juan County:													
Animas	11	3	210, 421	16, 268. 41	20. 46	16, 288. 87	301, 233	6	301, 239	819, 200	2, 048, 000		905, 349
Eureka	5		68	303. 12		303. 12	1, 773		1, 773	100	3, 000	2, 000	11, 945
San Miguel County:													
Iron Springs	11		136	144. 52		144. 52	4, 269		4, 269	2, 550	43, 800	1, 000	9, 679
Lower San Miguel		19			49. 76	49. 76		16	16				1, 749
Mount Wilson	1	1	1	3. 04	3. 43	6. 47	5	1	6				230
Upper San Miguel	24	10	66, 399	5, 991. 24	81. 00	6, 072. 24	62, 594	53	62, 647	109, 650	349, 200	32, 000	275, 792
Summit County:													
Breckenridge	7	91	269	213. 45	7, 639. 00	7, 852. 45	1, 850	1, 924	3, 774	700	38, 000		278, 345
Montezuma	4		73	10. 50		10. 50	1, 123		1, 123		7, 700		1, 378
Ten Mile	7	6	494	174. 22	26. 75	200. 97	1, 598	5	1, 603		46, 600		9, 784
Teller County: Cripple Creek	125	10	425, 242	127, 901. 20	48. 70	127, 949. 90	12, 555	1	12, 556				4, 479, 966
Total Colorado, 1934	929	967	1, 309, 187	309, 950. 23	14, 972. 99	324, 923. 32	3, 472, 445	3, 216	3, 475, 661	11, 2[illegible]4, 000	8, 435, 000	1, 544, 000	14, 884, 969
1933	614	286	845, 495	237, 502. 19	5, 325. 51	242, 827. 70	2, 184, 880	1, 260	2, 186, 140	9, 667, 000	4, 803, 000	2, 569, 000	[3] 7, 876, 122

[2] District figures combined to avoid disclosing output of one operator in the Blake district.

[3] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

ADAMS COUNTY

In 1934 small lots of placer gold were recovered by rockers and sluicing from the stream and bench gravel beds of Clear Creek, which flows east from Jefferson County into Adams County north of the city limits of Denver. Bullion dealers in Denver purchased most of the output in the form of dust and did not assay it for silver, but two lots sold to the Denver Mint averaged 0.862 fine in gold and 0.087 fine in silver. In former years (1922–32, inclusive) sluices placed below the waste flumes of sand- and gravel-washing plants along the creek in Adams County saved 1,116.54 ounces of gold and 165 ounces of silver, but none of these was operated during 1934.

ALAMOSA COUNTY

Small lots of gold ore were shipped to the Golden Cycle mill at Colorado Springs from the Red Eagle and Lucky Strike claims in the West Blanca district in 1934.

ARAPAHOE COUNTY

Individual placer operations in 1934 on the Platte River and Little Dry Creek south of the city limits of Denver in Arapahoe County and on Cherry and Dry Creeks southeast of Denver yielded many small lots of gold which were purchased chiefly by dealers in Denver. Six lots averaging 2.34 ounces each, sold to the Denver Mint, averaged 0.940 fine in gold and 0.042 fine in silver.

BOULDER COUNTY

In 1934 Boulder County produced 17,536.48 ounces of gold, 57,171 ounces of silver, 21,400 pounds of copper, and 69,000 pounds of lead compared with an output in 1933 of 4,402.51 ounces of gold, 11,926 ounces of silver, 4,000 pounds of copper, and 26,000 pounds of lead. Of the 217 operating lode mines in the county in 1934, 131 produced only small lots of ore, ranging from ½ ton to 25 tons.

Custom ores were purchased during 1934 by the St. Joe Mining & Milling Co., both at its Boulder Ore Sampling Works at Boulder and at its custom mill on Left Hand Creek near Gold Hill. The ore received at the sampler and the bulk of the concentrates made at the mill were shipped to the Golden Cycle mill at Colorado Springs. Other operators shipped ore and concentrates direct to the Golden Cycle mill and to the A.V. smelter at Leadville. Small shipments of high-grade ore were made to the small gold and silver refinery of the Colorado Smelting & Refining Co. at Denver.

Central district (*Jamestown*).—In 1934 several lessees on the Wano group shipped gold ore aggregating 3,174 tons to the Golden Cycle mill at Colorado Springs. Ore from the Alturas and Grey Eagle mines was treated at the St. Joe mill. The Mount Pleasant mine was operated 10 months and produced 1,051 tons of gold-silver ore. From the Pilot mine dump 239 tons were shipped to the Golden Cycle mill. High-grade silver ore from the Silver Band mine near Jamestown was shipped to the Colorado Smelting & Refining Co. at Denver. The Smuggler mine was operated 3 months, during which unwatering and retimbering were done and 200 tons of ore were concentrated in the company's 35-ton gravity concentration plant equipped with a Huntington mill and McAneny tables; the concentrates were shipped to the American Smelting & Refining Co. at Omaha, Nebr. Other mines in the Central district producing more than 25 tons were the Bondholder, Cracker Jack, Delaware group, Gladiator, Havana, John Jay, and King Wilhelm. Small lots of placer gold were recovered by sluicing operations along James Creek.

Gold Hill district.—The St. Joe 90-ton flotation mill on Left Hand Creek near Gold Hill was operated continuously after May 1, 1934, on custom ore and ore from company mines, the latter after June 1 mainly from the Grand Republic mine (Sugar Loaf district) which was purchased in May; after October 1 only company ore was treated, chiefly from the Grand Republic. The Little Johnnie 50-ton flotation mill at Salina was used by the McAnally Mining Co. to treat ores from the company's Gardner and Home Sweet Home mines and contract ore from the Lucky Star group at Gold Hill; dump ore from the Cash was also treated. The Slide Mines, Inc., which reopened the Corning Tunnel in 1933–34, began operation of its new 60-ton gravity- and flotation-concentration mill at the mouth of the tunnel early in 1934 on ores from the Klondike and Twin veins of the Corning Tunnel group. The mill was operated from March 1 to December 31 at an average of 40 tons a day, and treated 10,238 tons of sulphide ore containing 0.32 ounce gold and 0.855 ounce silver to the ton, as well as some copper, lead, and zinc minerals; concentrates produced totaled 1,178 tons and contained 2,716.67 ounces of gold, 7,869 ounces of silver, 12,884 pounds of copper, 55,012 pounds of lead, and 21,196 pounds of zinc. In addition, 356 tons of crude ore containing 260.15 ounces of gold and 495 ounces of silver were shipped direct to the Golden Cycle mill. The concentrates were shipped to the Leadville smelter. The equipment of the Slide mill consists of 1 Hardinge-Hadsel 20- by 5-foot pulverizing mill which crushes the 14-inch run-of-mine ore to flotation size, 3 No. 6 Wilfley tables, 1 Akins 45-inch classifier for dewatering tailings, one 6-cell Denver Sub-A No. 15 flotation machine, and 1 Akins 12-inch, duplex, low weir classifier for dewatering concentrates. The Black Swan flotation mill between Salina and Crisman was operated part of the year on ores from the Tambourine and Goldsmith Maid mines. Other mines producing 1 car or more of ore were the Belle, Big Horn, Big John, Black Cloud, Boulder Valley, Cash, Columbus, Fairfax, George Henry, Grandview, Hawkeye, Ingram, Mack, Maxmillian, McKnight, Montezuma, More Punch, Myrtle, Peacock, Plowboy, Prussian, Sakhrat, Sunshine, Sussex, Three Brothers, Wagoner Ranch, Washburn, White Crow, Winona, and Woodchuck. Various small placer operations on Left Hand and Four-Mile Creeks yielded a little gold.

Grand Island district (Cardinal, Caribou, Eldora, and Nederland.)—Gold-silver-lead ore was shipped in 1934 from the Boulder County Tunnel to the Golden Cycle mill at Colorado Springs and to the A. V. smelter at Leadville. This property, the largest producer of metals in the Grand Island district in 1934, was operated by tne Tungsten Production Co., Inc., in 1934, but was sold to the Rocky Mountain Gold Mines, Inc., which will operate it in 1935. Other producers of more than 25 tons of ore were the New York, St. Louis, and Stranger. Placer gold was recovered by individuals sluicing on Beaver Creek.

Magnolia district.—Shipments of gold ore from the Magnolia district were made in 1934 to the Boulder Ore Sampling Works and to the Golden Cycle mill. Producing mines were the Ben C. Lowell, Dardanella, Eclipse, Golden Glow, Graphic, Hereafter, KeKeonga, Keystone, Little Pittsburg, Magnolia Tunnel, Mair Pointon, Mountain Lion, New Year-Fortune group, Senator Hill, Snow Flake, Pickwick, Rocky Mountain-Mammoth, and Rusty Dime.

Sugar Loaf district.—The Grand Republic mine was the largest producer of gold in Boulder County in 1934. Steady shipments of ore were made to the Golden Cycle mill from January through May. In June operation of the mine was begun by the St. Joe Mining & Milling Co., which hauled the ore to its mill on Left Hand Creek (Gold Hill district) for treatment. The Wood Mountain 50-ton flotation-gravity concentration mill of the Tungsten Production Co., Inc., was operated during September and October on ores from the Wood Mountain mine; ore also was shipped to the Golden Cycle mill. A lessee of the Metals Production Co. 100-ton flotation-gravity concentration mill at Wallstreet treated 1,100 tons of ore from various operators nearby, including some from the Nancy group; other ores from this group were shipped to the Golden Cycle mill. The Poorman-Relief group was an important producer of gold during the year. The Orphan Boy 5-ton amalgamation and table-concentration mill was operated 45 days on ore from the Orphan Boy mine, operated 60 days. Other producers of more than 25 tons were the Croesus, Dime, Little Belle, Livingston, Logan, Milan, Pine Shade, Pride of the West, Recluse, Smoky Hill, Sugarloaf, Wisconsin, and Yellow Star. Placer gold was produced at the Colby placer, operated 6 months during the year.

Ward district.—In 1934 the Ward-Big Five Gold Mining Co. continued opening up old workings and doing development and testing work begun in 1933 on the Adit Tunnel of the North American Mining Co. and in the mines connected with the tunnel system. Repairs on the Madeline and Columbia shafts at Ward were completed, and several lots of ore were shipped to the Golden Cycle mill during March and April. The Big Five 50-ton flotation-gravity concentration mill was reconditioned in 1934 and operated during the last 6 months of the year, treating 3,245 tons of ore assaying 0.18 ounce gold and 0.12 ounce silver to the ton; concentrates produced totaled 239 tons and assayed 1.80 ounces gold and 2.6 ounces silver to the ton and 1.3 percent copper, 1 percent lead, 35 percent iron, and 19 percent insoluble. Gold-copper ore from the Golden Queen mine was shipped to the Midvale (Utah) and Leadville (Colo.) smelters, and shipments of gold ore were made to the Golden Cycle and St. Joe mills from various properties in the Ward district. Mines producing 1 car or more of ore, in addition to the two mentioned, were the Grandview, Hawkeye, Idaho, Milwaukee, New Market, N.R.A., Puzzler, Red Cloud, and White Raven.

CHAFFEE COUNTY

Arkansas River district (Buena Vista, Salida).—Placer gold was produced in 1934 from sluicing and panning operations along the Arkansas River from Buena Vista south to the Fremont County line.

Chalk Creek district (*Romley, St. Elmo*).—The bulk of the metal output from Chaffee County in 1934 was produced from the Mary Murphy mine, worked by lessees on a royalty basis. Gold-silver-lead ore was extracted from the upper levels and shipped to the Golden Cycle mill at Colorado Springs, and small lots of smelting ore went to the Leadville smelter. The Carey mill at St. Elmo was operated a short time by the Ore & Chemical Corporation, which made test runs on tailings from the old Pawnee stamp mill and produced 5 tons of gold concentrates containing a high percentage of zinc.

Four Mile district.—A small lot of gold ore was shipped in 1934 to the Leadville smelter from the Little Annie C. C. group in the Four Mile district, in secs. 5 and 6, T. 13 S., R. 78 W., on the east side of the Arkansas River.

Granite district.—Small lots of smelting ore were shipped to the Leadville smelter from several prospects in the Granite district in 1934. Placer gold was recovered by sluicing operations along the Arkansas River near Granite, by drift mining and sluicing at the Old Channel placer, and by sluicing at the Cache Creek placer 2½ miles west of Granite.

Monarch-Garfield district.—In 1934 lessees on the Madonna group produced lead-silver-copper ore by gophering.

Riverside district.—A small output of gold ore was made in 1934 from the Big Chief, Sunnyside, and one other claim in the Riverside district; 1 car of copper ore was shipped from the Lucky Buck mine, presumably in the Riverside district.

Trout Creek district.—One lot of gold ore was shipped from the Eastman mine to the Golden Cycle mill in 1934.

Turret district.—Shipments of gold ore were made in 1934 from the Florine, Gold Crown, and North Side mines to the Golden Cycle mill.

CLEAR CREEK COUNTY

Alice district (*Yankee, Lincoln*).—One battery (5 stamps) of the 10-stamp, 25-ton, amalgamation-gravity concentration mill at the Gold Anchor mine, idle for 15 years, was repaired in 1934 and put in operation for test work on ores from the Gold Anchor and Lalla mines. A total of 187 tons was treated and yielded amalgamation bullion containing 24.93 fine ounces of gold and 2 fine ounces of silver; it yielded also 7 tons of concentrates of which 4 tons, containing 1.72 ounces of gold, were sold. Gold ore from the Ottawa mine was sold to the Clear Creek-Gilpin Co. Sampler at Idaho Springs. The Reynolds stamp mill was operated for a short period on ore from the Reynolds mine. Gold ore from the San Juan mine was shipped to the Golden Cycle mill at Colorado Springs and to the Clear Creek-Gilpin Co. Sampler at Idaho Springs.

Argentine district.—Producing mines in the Argentine district in 1934 were the Hamill group, National, and Santiago. Crude lead-silver-gold ore from the National mine was shipped to the Leadville smelter. Part of the output from the Santiago was concentrated at the Watrous custom mill at Silver Plume and part at the Argo mill at Idaho Springs; the concentrates (gold-silver, with some lead and copper) were sold to the Leadville smelter. Dry silver ore from the Hamill group was shipped to the sampler at Idaho Springs.

Empire district.—The D. A. Odell Mines did development work on a group of claims near Empire during 1934 and operated the Gold Dirt 100-ton flotation mill from July 14 to November 15 on gold ores extracted from the Crown Prince-Atlantic-Rifle group; this company was the largest producer of gold in the Empire district. The Conqueror gravity-concentration mill, using water for power, was operated intermittently by the Viking Gold Mines Corporation on ore from the Conqueror mine. A test lot of ore was shipped from the Bard Creek mine, and remodeling of the Bard Creek 50-ton amalgamation-gravity concentration mill to flotation was started. Other producing mines in the district included the Forgotten, Gold Dirt, Golden Eagle, Gold Fissure, Keystone, Mint, Neath, Pittsburg, and Sprankel. Small sluicing operations on Clear Creek at Empire yielded a little placer gold.

Griffith (Georgetown-Silver Plume) district.—The output from the Pulaski and Zeda mines, the principal producers in the Georgetown district in 1934, was treated as custom ore in the Watrous 65-ton flotation mill. The East and West Griffith groups were consolidated and reopened by the Georgetown Mining Co., which devoted most of the year to retimbering, clearing of caves, and development in the mines but began shipping ore before the end of the year. Other producers were the Backbone, Big Chief, Butte Mining Co. property, Capital Tunnel, Commonwealth Tunnel, Cross Tunnel, Kelly, Payrock, Raven Hill, and Shively mines.

Idaho Springs district.—The Clear Creek & Gilpin Ore Co., which had reopened its sampler at Idaho Springs in December 1933, continued in 1934 as the Clear Creek-Gilpin Co. to purchase ore and concentrates from operators in Clear Creek and Gilpin Counties and in July began treating much of the purchased ore in the company's new 75-ton concentration-flotation mill, built during the year as part of the sampler enterprise. In June the King Kong Mines leased the Argo mill to treat ore from the company's P. T. mine on the spur separating Spring Gulch and Clear Creek but also used it to treat custom ores. The Alma Lincoln Mining Co. was the largest producer of gold, silver, copper, and lead in the Idaho Springs district in 1934. The ore was extracted from the lower levels of the Lincoln mine and milled in the company flotation mill 300 feet from the tunnel entrance to the mine. The mill was operated 320 days at a daily average of 50.7 tons, producing 1,787 tons of gold-silver-lead-copper-[zinc] concentrates containing 3,079 ounces of gold, 10,273 ounces of silver, 97,212 pounds of lead, and 27,766 pounds of copper. The Tar Heel Mining Co. continued shipments of crude ore from the upper levels of the Lincoln mine. The Mattie group was operated intermittently, nearly all the ore being treated in the amalgamation-concentration mill at the mine. The Combination mill at Idaho Springs was operated for a short period on ores from the Iron mine in Gilpin County. Lessees on the North American group of mines, connected with the Central (Big Five) adit, produced ore from the Belman, Fulton, and Edgar mines. Other mines producing 1 car or more of ore included the Aetna, Anoka, Bismark, Brighton, Calvin, Carissa (dump), Chicago, East Lake, Gem group, Golden Edge, Hoosier, Humboldt, Hyland, Invincible, Lady Bell, Lexington group, Lord Byron, Ocean Queen, Old Settler, Oregon, Shafter, Silver Horn, Specie Payment group, Stanley, Treasure Vault, Tropic, West

Gold, Whale, and Wheatland Tunnel. At the Gold Pit placers, a "flour" gold extractor, employing centrifugal force and amalgamation, recovered 31.14 crude ounces of placer gold 0.926 fine in gold and 0.070 fine in silver. The Clear Creek Gold Placer Mining Co. completed the installation of a gasoline power shovel, trommel, stacker, and sluice box on Clear Creek ½ mile above Floyd Hill and produced a small quantity of gold before the end of the year. Many individuals and prospectors produced small lots of placer gold by panning, rocking, and sluicing on Clear Creek.

Montana district (*Lawson, Dumont*).—The Corporation of America Mines mill at Dumont was operated for a short period in 1934 on ores from the Clear Creek and Gilpin Tunnel group. The Princess of India group produced silver-gold-lead-[zinc]-copper sulphide ore, most of which was milled at the Argo mill at Idaho Springs. Dry silver ore was produced at the American Sisters mine (dump). Most of the other output from the Montana district came from the Albro, Bellevue-Hudson, De Caprivi (Climax), Millington, and Morning Star mines.

Trail district.—Working from the McClelland Tunnel in 1934, the Byron Mining Co. unwatered the Freeland group of mines and, after unwatering, continued development and mining throughout the year; the company 45-ton flotation-gravity concentration mill at the mouth of the drainage tunnel near Dumont was operated during May and from August through December. Power for part of the year was supplied by company water power. The company milled 2,582 tons of ore averaging 0.235 ounce gold and 0.896 ounce silver to the ton and produced 350 tons of mixed table and flotation concentrates averaging 1.5998 ounces gold and 5.955 ounces silver to the ton. Operations were suspended in March 1935. Ore from the Donaldson mine was trucked to the Argo mill at Idaho Springs for treatment, and a small output was made from other mines and prospects.

COSTILLA COUNTY

Grayback district.—Sluicing operations at the Last Chance No. 3 placer in Grayback Gulch and hydraulic operations on the property of the Trinchera Land Co. on Grayback Mountain yielded the metal produced in Costilla County in 1934.

CUSTER COUNTY

Hardscrabble district (*Westcliffe, Silver Cliff*).—From the King of Carbonates mine 79 dry tons of carbonate ore, containing 25.65 ounces silver to the ton, 6.1 percent lead, and 1.1 percent copper, were shipped in 1934 to the Leadville smelter. Dry silver ore was shipped to the Golden Cycle mill from the Last Quarter and Maine No. 2 mines; the Maine No. 2 also produced 3 tons of lead-silver ore which was sent to the Leadville smelter. A small lot of gold-silver ore was produced at the Dixie mine. Two cars of lead-silver ore were shipped to smelters from the Passiflora mine.

Rosita Hills district.—Twelve tons of ore, containing 13.72 ounces of gold and 78 ounces of silver, extracted from near-surface levels of the old Bassick pipelike ore body at Querida were shipped to the Golden Cycle mill in 1934.

DELTA COUNTY

Sluicing of bench gravel in 1934 at the White Arrow placer in Delta County on the Gunnison River above the junction of the North Fork yielded placer bullion 0.750 fine in gold and 0.240 fine in silver. The Ruby Wear placer, also on the Gunnison River, was operated part of the year, but the owner reported that the gold was very fine and cost so much to recover that the property probably never would be operated again. Other placers along the river produced small lots of gold.

DENVER COUNTY

Numerous lots of placer gold ranging in quantity from a minimum of 0.0125 ounce to a maximum of 1 ounce and reported as requiring 1 day to 6 weeks to mine were produced by individuals engaged in rocking, sluicing, and panning on the Platte River and Cherry Creek within the bounds of the city and county of Denver in 1934. The increase in price of gold during the winter of 1933–34, a convenient market in Denver for small lots, and no other employment were factors that induced many of the operators to work at placering continuously during the summer months and later than usual in the fall in spite of meager cash returns for the time consumed. Refiners, assayers, jewelers, and dental-supply firms purchased nearly all the gold. Only one combined lot, weighing 2.43 ounces after being melted and having a fineness of 0.962 in gold and 0.035 in silver, was sold direct to the Denver Mint. Bullion buyers also purchased 1,486 crude ounces of placer gold from other western mining districts, and through their cooperation it was possible to determine the source of such gold by States, counties, and districts. In addition, the Colorado Smelting & Refining Co. purchased specimen gold and gold-silver precipitates and small tonnages of high-grade gold and silver ores and concentrates from other districts for treatment and refining at its plant in Denver, which includes as equipment a Denver Quartz Mill jaw crusher, Chilian-type mill, Wilfley table, and two reverberatory refining furnaces.

DOLORES COUNTY

Pioneer district (*Rico*).—Most of the ores shipped from Rico in 1934 were zinc-lead-copper-silver-gold sulphide ores, with silver the metal of chief value. As no milling plants were operating in the district the ore was shipped crude to milling plants or smelters at Midvale or Tooele, Utah, or to the smelter at Leadville, Colo. Producers were the May Leasing Syndicate on the Burns mine, the Gold Anchor group, the Falcon Lead Mining Co. property, the Hicks Lease on the Rico Townsite, the Rico Consolidated Mining Co., the Rico Enterprise Mining Co., and the Union Carbonate group. Several small lots of placer gold produced at the Elora placer claim were sold to the Denver Mint.

DOUGLAS COUNTY

Numerous small lots of placer gold were purchased by jewelers, refiners, and other dealers in Denver from individuals and prospectors sluicing and panning along stream beds and in various gulches in Douglas County in 1934. At a few places, mainly the Happy Canyon placer, enough gold (2 ounces or more) was accumulated to permit direct deposits at the mint. Location of the placers, as given by the miners, included Cherry Creek, Dry Creek, Happy Canyon, Lemon Gulch, Newlin Gulch, Plum Creek, and Russellville Gulch.

EAGLE COUNTY

Burns and McCoy district.—Prospectors recovered small lots of gold in 1934 by panning and sluicing along the Colorado River, but most of the output of the Burns district was produced by the Gately placer operation from bench gravel on the Juniper claim near the Colorado River, 5 miles west of McCoy. A centrifugal pump run by a gasoline engine furnished water, and the material was pushed to the sluice by a gasoline tractor and "bulldozer." Between July and November 5,323 cubic yards of gravel were handled and yielded 68.85 crude ounces of bullion averaging 0.847 fine in gold and 0.142 fine in silver.

Red Cliff (Battle Mountain) district.—The principal producer of silver and copper in Colorado in 1934, and an important producer of gold, was the Eagle mine of the Empire Zinc Co. (New Jersey Zinc Co.) through its output of copper-iron-silver-gold sulphide smelting ore shipped to the Garfield (Utah) smelter from ore bodies in the Leadville limestone formation, dipping northeastward under Battle Mountain near Red Cliff. The company 600-ton flotation mill built partly underground in Eagle Canyon below Gilman was not operated in 1934. Shipments of gold ore were made to the Leadville smelter or to the Golden Cycle mill from other mines in the Red Cliff district, including the Alligator, Ben Butler, Ground Hog, Pine Martin, and Star of the West (high-grade gold ore).

ELBERT COUNTY

Apparatus consisting of a 3-hp. gasoline engine on a dredge-type washing plant with 10 buckets, having a maximum capacity of 5 yards per hour, was built at the Crail Ranch placer on Ronk Creek by the operator who handled 1,500 yards of gravel and recovered 10 ounces of placer bullion having a fineness of 0.990 in gold.

EL PASO COUNTY

The ores from the Cripple Creek district, Teller County, have for many years been treated at the Golden Cycle mill [2] at Colorado Springs, El Paso County. These ores are gold-[silver]-sulphotelluride ores—pyrite and tellurides, mainly calaverite, with siliceous gangue. In recent years much of the material has been dump ores containing, before 1934, as low as 0.1125 ounce gold per ton and, in 1934, as low as 0.06 ounce per ton. When built in 1907 the mill was a 1,200-ton roast-amalgamation [3] -cyanidation mill, but in 1927 supplementary equipment was installed to treat gold pyrite ores and concentrates, siliceous silver ores, and miscellaneous ores produced outside the Cripple Creek district in an all-sliming cyanidation circuit without preliminary roasting. In 1929 crushers, ball mills, and Fahrenwald flotation machines with a capacity of 300 tons per day were installed to treat any ores offered, including zincky ores. The mill ceased paying

[2] Harner, L. S., Milling Methods and Costs at the Golden Cycle Mill, Colorado Springs, Colo.: Inf. Circ. 6739, Bureau of Mines, 1933, 18 pp.
[3] Free gold saved on blankets (in later years on canvas) and amalgamated in iron arrastre.

for zinc and ceased making zinc concentrates in 1930. In 1934 a new 450-ton flotation mill was almost completed near the sampling and crushing houses. The old flotation equipment will be moved to the new building. The flotation plant was operated chiefly in treating low-grade sulphotelluride ores from the Cripple Creek district in 1934 but also was used to float out graphitic or carbonaceous gangue material with the lead and copper from ore from the London mine of the Mosquito district, Park County, thus making high-grade gold-[silver-lead-copper] concentrates and eliminating carbon and copper—both cyanicides; the other product was iron concentrates, which were roasted and cyanided. The lead-copper concentrates were given preliminary cyanide treatment before shipment to the smelter. Crude ore from other counties also was treated by flotation. Purchased iron concentrates were roasted, amalgamated, and cyanided. The bulk of the ore received was from the Cripple Creek district; this ore with all the concentrates produced from the Cripple Creek ores went through the regular process of roasting, amalgamation, and cyanidation. The tailings from all operations were cyanided. New crushing equipment and enlargement of cyanide tanks allowed the mill to treat over 1,500 tons in October. The daily average for 365 days was 1,157 tons.

FREMONT COUNTY

All the metals produced in Fremont County in 1934 came from placers operated by individuals and prospectors along the Arkansas River from the Chaffee County line down stream to Florence. Most of the gold recovered from stream gravel came from the Willmoss placer close to the Chaffee County line and the Jay Hill placers near Howard. The largest production, however, came from sluicing operations on old smelter and mill tailings dumps at Florence.

GILPIN COUNTY

Southern districts (Black Hawk, Central City, Nevadaville, Russell Gulch).—Low-grade gold ore extracted from "The Patch" property at Nevadaville by shrinkage stoping and glory-hole mining and transported from the mouth of the La Cross Tunnel (adit) by a 3,000-foot aerial tram to the Chain O'Mines amalgamation-gravity concentration-selective flotation mill at Central City for treatment yielded the largest output of gold and silver in the southern districts of Gilpin County in 1934. The property was operated during January by the Chain Syndicate, was idle for several months, and was then reopened by the Central City Gold Mines Co., which continued production for the remainder of the year. The Pittsburg mine was operated from September 1 to December 31 by the Russell Gulch Mining Co., which treated ore from the mine and dump in the amalgamation-flotation-gravity concentration mill on the property, using only the gravity-concentration equipment. The Beatrice Mining Co. operated its old Bolen gravity-concentration mill 90 days at a daily average of 30 tons during the last 4 months of the year on ore from the Gregory Mill Sites Nos. 33 and 35. The 10-stamp mill of the War Dance Mines, Inc., at Central City was operated intermittently on company ores, about half of which were mined and brought to the mill in small lots by lessees. The Farr-Western custom mill at Blackhawk treated test lots of ore derived from development work at the Gregory-Bates

Mining Co. properties and from various individual prospecting and small mining operations. Important producers of crude ore shipped to mills or smelters outside the southern districts for treatment included the Becky Sharpe, Delmonico, Druid, Iron, Martin (Old Anchor), Old Town, Perrin, Saratoga, Snowden, and West Notoway mines.

Sluicing and drift mining by the Eugene Mines, Inc., on North Clear Creek at Blackhawk yielded the largest individual output of placer gold in the southern districts, but the aggregate output of 101 small sluicing operations in Eureka, Nevada, Russell, and other gulches and on North Clear Creek was 247 fine ounces.

Northern districts.—A watchman at the Perigo Mines Co. property in Gamble Gulch used 5 of the 30 stamps in the Perigo 30-ton amalgamation-concentration mill in 1934 to treat a small tonnage of ore which he extracted from the Perigo mine. Some output was made from the Mackey, Metha, Morning Star, Providence-Newport, St. Louis, We Got Em, and other lode mines. A small hydraulic operation at the Fontleroy placer and sluicing operations in Gamble, Lump, Missouri, and Moon Gulches and along South Boulder Creek, mainly at the Pactolus placer, yielded placer gold.

GRAND COUNTY

Elk Mountain district (*Hot Sulphur Springs*).—Sluicing operations on Willow Creek and other streams north of Granby yielded a small output of placer gold in 1934.

La Plata (*Jones Pass*) *district* (*Empire*).—One lot of dry silver ore with a gross metal content of 94.6 ounces silver and 0.09 ounce gold per ton was shipped from the Weir lode mine to the Golden Cycle mill.

GUNNISON COUNTY

Cochetopa (*Parlin*) *district.*—In 1934 shipments of gold ore were made to the Golden Cycle mill from the Dividend (test lot only), Lucky Boy No. 1, and Lucky Strike-Chance mines. A Huntington No. 5 mill, Gibson amalgamator, and Wilfley table were installed at the Lucky Boy No. 1 to treat ores locally in 1935.

Domingo (*Goose Creek, White Earth*) *district* (*Madera, Powderhorn, Spencer, Vulcan*).—Prospecting at the Gold Dollar claim and sampling operations at the Gold Pink claim in the Carpenter group resulted in the shipment in 1934 of small lots of gold ore to custom plants in Colorado and Utah. Lessees on the Old Lott and Rudolph mines shipped one lot of gold-silver ore from each to the Golden Cycle mill.

Elk Mountain district.—Test shipments were made in 1934 from the dump of the Ruby Chief group to the Midvale (Utah) smelter, and 4 tons of silver-lead ore were shipped from the Silver Spruce mine to the Golden Cycle mill. A little silver ore was produced and shipped from the Madeline mine. A small lot of amalgamation bullion was shipped to the Denver Mint by the Lubricator Mines. Placer gold was produced from small sluicing operations at the Hayden-McCleod and one other placer in Washington Gulch.

Gold Brick district (*Ohio*).—In 1934 the Carter Mines Co. operated its 75-ton amalgamation-concentration mill continuously, but the shortage of water in Gold Creek (which furnishes power to run the mill) permitted operation for only one shift a day. This company was the leading producer of gold and silver in Gunnison County during the year. Other producing mines in the Gold Brick district were the Dodson, Gem, Gold Links, Gold Monument, Golden Wedge, Idoline, Raymond group, Sacramento, and Victory.

Quartz Creek and Box Canon districts.—Starting July 10, 1934, the Roosevelt Gold Mines Co. extracted about 425 tons of ore (mainly for a mill test) from the "Camp Bird" mine, one of the Roosevelt Gold Mines group, and treated it in the 10-ton stamp-plate amalgamation-gravity concentration mill on the property, operated at one-half capacity intermittently one shift a day for about 60 days. The amalgamation bullion recovered was shipped to the Denver Mint; 10 tons of concentrates produced were not sold during the year. Other producers were the Fairview-Cleopatra and the King Solomon mines.

Rock Creek district (Marble).—Dry silver ore was shipped to the Leadville smelter from the Black Queen and one other mine in the Rock Creek district in 1934.

Taylor Park (Tin Cup) district.—Test lots of gold ore from the Red Buck claim and 3 tons of sacked gold ore from a prospect in the Tin Cup district were shipped to the Golden Cycle mill in 1934. Lessees on the property of the Gunnison Cattlemen Association in Taylor Gulch recovered 19.16 fine ounces of placer gold from ground-sluicing operations. The Rainbow placer in Bertha Gulch was hydraulicked, and miscellaneous small placers in the district were operated with sluices.

Tomichi district.—The only production from the Tomichi district in 1934 was lead-zinc ore shipped to the Midvale (Utah) smelter from the Morning Star mine.

HINSDALE COUNTY

Galena district.—Lessees on the Fanny Fern mine shipped small lots of silver-lead ore to smelters in 1934.

HUERFANO COUNTY

Bullion dealers in Denver purchased small lots of gold in 1934 from prospectors who reported that it had been recovered in Huerfano County by placer methods.

JACKSON COUNTY

Placer ground on Alder Gulch on Independence Mountain north of Cowdrey was worked in 1934 by several groups of individuals. One group used Denver mechanical pans; another washed the gravel in a tube-type mill, propelled by a gasoline engine, before passing it on to sluices; and a third group used a centrifugal pump and rotary "puddler" propelled by a gasoline engine to wash the gravel into a trommel screen from which the undersize went to sluices and the oversize was discarded. One operator reported that lack of water for sluicing in that region caused serious loss of time.

JEFFERSON COUNTY

The Humphreys Gold Corporation operated its traction dry-land dredge at the Quaintance Lease in the bed of Clear Creek below Forks Creek from May 15 to November 15, 1934, and handled 197,249 cubic yards of gravel which yielded 2,929.44 crude ounces of gold bullion including 24 ounces contained in placer concentrates sold to the Leadville smelter. The bullion sold to the Denver Mint had a fineness of 0.8385 in gold and 0.126 in silver. The other output of gold and silver from Jefferson County came from small panning and sluicing operations along Clear Creek from the point where it enters Adams County up stream to a few miles above Golden.

LAKE COUNTY

LEADVILLE DISTRICT

The Leadville district in 1934 produced 28,433 tons of ore yielding, in terms of recovered metals, 14,282.09 fine ounces of gold, 83,573 fine ounces of silver, 90,400 pounds of copper, 1,047,800 pounds of lead, and 1,029,000 pounds of zinc compared with 18,298 tons of ore yielding 10,344.70 ounces of gold, 35,507 ounces of silver, 15,000 pounds of copper, 1,009,700 pounds of lead, and 2,492,000 pounds of zinc in 1933.

Of the total ore mined in the Leadville district, 22,764 tons (80.1 percent) were classed as dry and siliceous gold or gold-silver ore in 1934, compared with 7,305 tons (39.9 percent) classed as dry gold, gold-silver, or silver ore in 1933, 3,358 tons (77.4 percent) in 1932, 9,014 tons (36.2 percent) in 1931, and 32,243 tons (24.6 percent) in 1930.

Gold, which follows silver, zinc, and lead, in the order given, in total recorded value of output in the district through 1934, has ranked first in annual value since 1932; in 1934 it constituted 77.9 percent of the total value of the district output of the five metals (including copper).

The A. V. lead bullion-leady copper matte smelter of the American Smelting & Refining Co. was operated continuously (one furnace) as a lead-bullion plant with subsidiary leady-copper matte plant during the year. The copper furnace installed in 1932 was not operated in 1934. The second lead furnace prepared for operation in 1934 was started in March 1935. All the ores and concentrates treated in 1934 came from Colorado mines.

No ore was treated in concentration mills in the district in 1934. The bulk of the ore mined was smelted direct at the A. V. smelter, but some gold and gold-silver ores were shipped to the Golden Cycle mill at Colorado Springs for treatment. Zinc-lead-silver sulphide ore was shipped to the pigment plant at Coffeyville, Kans. Specimen gold went to the Denver Mint.

The Ibex Mining Co. was the largest producer of gold, silver, and copper in the district in 1934. Other important producing lode mines included the Ballard, Dolly B, Fanny Rawlings, Fortune, Lilian, New Monarch, New Vinnie, President, Rock Hill Mines Co. property, Tribune, Valley, Venir, and Zenda Leadville Mining Co. property.

At the Hector placer in Buckeye Gulch equipment consisting of a ¾-yard power shovel using gasoline engines for power, washer with 3- by 8-foot screen, and 2 belt conveyors was operated about 4 months between June and October. The Star-Norton placer ground in California Gulch was worked for a period by special machinery consisting of a gasoline power shovel, trommel screen, and sluices. Various placers in the district were worked by small-scale methods.

OTHER DISTRICTS

Granite district.—The Belle of Granite and Hattie Jane were the only producing lode mines on the Lake County side of the Granite district in 1934. Placer gold was recovered by individuals sluicing on the Arkansas River north of Granite.

St. Kevin district.—The Amity mine was operated continuously in 1934 from May 1 to the end of the year and produced 158 tons of gold-silver ore averaging 0.295 ounce gold and 15.67 ounces silver per ton. The Griffen mine produced 38 tons of gold-silver ore averaging 0.932 ounce gold and 22 ounces silver per ton.

Tenmile (Climax, Fremont Pass) district.—In 1934 the Climax Molybdenum Co. mill at Climax on Fremont Pass was operated 363 days at a daily average of 3,515 tons and produced molybdenum sulphide concentrates containing 8,378,683 pounds of elemental molybdenum.

Molybdenum production at the Climax mill in Colorado, 1924–34

	Elemental molybdenum (pounds)		Elemental molybdenum (pounds)
1924 (idle first 7 months; operated last 5 months)[4]	156, 935	1929	3, 529, 295
1925	821, 757	1930	3, 083, 000
1926	1, 057, 367	1931	2, 644, 399
1927	1, 858, 228	1932	1, 913, 395
1928	2, 957, 845	1933	5, 028, 695
		1934	8, 378, 683

Twin Lakes district.—The output from lode mines in the Twin Lakes district in 1934 came from the Columbine, Eureka, Little Joe, and White Star claims and from two prospects. At the Derry Ranch placers, 1 drag-line excavator using gasoline for power, with a capacity of 1,500 cubic yards per 24 hours, and 2 dry-land dredges were operated from September 6 to December 31.

LA PLATA COUNTY

The American Smelting & Refining Co. lead bullion-leady copper matte smelter at Durango, which was closed November 30, 1930, remained idle in 1934.

California (or La Plata) district (Hesperus, La Plata).—The May Day Milling Co. operated its 50-ton flotation mill in 1934 at an average daily rate of about 44 tons for 300 days on ore from the May Day mine. Gold-silver concentrates were produced and sold to the Leadville smelter. The output from the Gold King group of the La Plata Mines Co. was chiefly crude smelting ore; only a small quantity of ore was treated in the La Plata mill. The Lucky Discovery Gold, Inc.,

[4] Idle from April 1919 to Aug. 1, 1924.

operating the Lucky Discovery-Lucky Moon-Old Comfort group, constructed a sorting plant, installed a compressor and electric power plant on the surface, and did underground development work including diamond-drill tests. Several cars of ore extracted during development and hand-sorted were shipped to the Leadville smelter. Shipments of gold ore were made to the Golden Cycle mill from the Bessie G mine, operated until May by the Chamber of Commerce Lease and from then to the end of the year by the Champion Gold, Inc. The Mountain Lily was the only other mine in the California district that produced as much as 1 ton of ore in 1934. One lot of placer gold was recovered at a small sluicing operation on the Animas River.

Needle Mountain district.—The metal output from the Needle Mountain district in 1934 was made from gold ore produced at the Bobby, Grizzly King, and Lost Lode mines and shipped to the Golden Cycle mill.

LARIMER COUNTY

Ore was shipped from several mines and prospects in Larimer County in 1934. The Little Mary Mason mine in the Masonville district produced most of the gold; it came from high-grade ore shipped to the Golden Cycle mill. The output of silver was mainly from high-grade silver ore reported as having been mined from the Rockfield claim, Larimer County; the location by district was not given. A small output of gold was made from the Fairview and Little Wonder mines in the Manhattan district. A lot of gold ore from the Vagabond prospect in the foothills 7 miles northwest of Berthoud was shipped to the St. Joe mill in Boulder County. A small lot of low-grade gold ore from the Little Bobby prospect, also in this area, was shipped to the Golden Cycle mill.

LAS ANIMAS COUNTY

Development work was carried on throughout 1934 at the "Little Mattie" mine on West Spanish Peak 18 miles westerly from Aguilar, and 3 tons of silver-lead ore saved during the year were shipped to the Leadville smelter.

MESA COUNTY

One car of ore assaying 14.5 percent copper and 9.34 ounces silver to the ton was shipped during 1934 to the Garfield (Utah) smelter from the Missouri Girl mine 30 miles southwest of Grand Junction. Sluicing operations along the Gunnison River yielded small lots of placer gold.

MINERAL COUNTY

Creede district.—Due to the United States Treasury increase in the price paid for silver in December 1933 shipments of silver ore from Creede were resumed in 1934 after the district had been inactive since 1930. The bulk of the ore was shipped to the Leadville smelter, but some also was shipped to the Golden Cycle mill. Producing mines were the Amethyst, Commodore, Consolidated Moses Solomon Mines Co. group, Corsair, Creede Mines group, Del Monte-Last Chance-New York-Pittsburg group, and Molly S.

MOFFAT COUNTY

Fourmile (or Timberlake) district.—At the Alice claim of the Selig mines in Timberlake Gulch about 600 cubic yards of bench gravel and old placer tailings were sluiced in 1934 and yielded 32.01 crude ounces of placer gold averaging 0.942 fine. Other placers on Timberlake and Fourmile Creeks and near Great Divide produced smaller quantities of gold.

Lay district.—Lessees on the Wallihan property on Lay Creek in 1934 recovered placer gold with sluices and a Goody placer machine.

Round Bottom district.—One lot of gold recovered by sluicing at the Hoover placer on the Yampa River 12 miles southwest of Craig was shipped in 1934 to the Denver Mint.

MONTEZUMA COUNTY

The Red Arrow mine was operated continuously in 1934 by the Red Arrow Gold Corporation until December 1, when work was suspended. The output from the mine during this period and one lot of smelting ore mined in 1933 but not sold in time to be included in figures for that year totaled 124 tons of ore containing 435 ounces of gold, 828 ounces of silver, and 707 pounds of copper and high-grade gold ore and nuggets yielding 265 ounces of gold and 50 ounces of silver. The Hesperus Mining Co., operating the Doyle group of claims in Rush Basin, did development work in the mines and treated ore for a short period in the remodeled 100-ton flotation mill on the property; the concentrates made and shipped to the Leadville smelter contained only gold and a very small amount of silver. Dry gold ore from the Sasser mine was shipped to the Golden Cycle mill. A little placer gold was recovered from small sluicing operations on the Mancos River.

MONTROSE COUNTY

La Sal district.—At the Hardscrabble placer on the Dolores River 24 miles southeast of Gateway the operator, using a 2½-inch pump powered by a small gasoline engine for bringing up the water, sluiced in 1934 about 500 yards of bench gravel from May 10 to the end of the year and recovered 14 crude ounces of gold 0.803 fine. The operator of the Dolores placer nearby, using the same method, worked from February 20 to December 15 and washed approximately 2,178 yards which yielded 39.58 crude ounces 0.788 fine in gold. Small sluicing operations at 3 other placers on the Dolores River produced small lots of placer bullion.

Naturita district.—By intermittent hydraulicking when water was available (totaling 10 days in 1934) about 1,000 yards of gravel were washed at the Cottonwood placer on the San Miguel River and yielded 11.63 fine ounces of gold. Small sluicing operations along the river resulted in the recovery of many small lots of placer gold which were sold chiefly to dealers in Salt Lake City, Utah, and Grand Junction, Colo.

OURAY COUNTY

Ridgway district.—Placer gold was produced in 1934 from small sluicing operations along the Uncompahgre River.

Sneffels district.—In 1934 production of ore was continuous (365 days) from the upper workings of the Camp Bird mine, operated by the King Lease. The ore is amalgamated and concentrated in the King Lease mill in Imogene Basin at the mouth of the upper adit. The capacity of the mill is 75 tons per 24 hours. The products consisted of amalgamation bullion and of concentrates which were classed as lead-copper with the principal value in gold but which also carried 22.9 ounces of silver for each ounce of gold and a considerable quantity of zinc; the zinc naturally was not saved at the Leadville smelter. The output from the Trust Ruby and Governor mines was principally gold-silver bullion made by hand-crushing and amalgamating high-grade gold ore, but small shipments of crude ore were made from both mines during the year. Amalgamation bullion was produced from one other mine in the Sneffels district, and a small lot of gold ore, presumably from a prospect, was shipped to the Leadville smelter.

Uncompahgre district (Ouray).—G. A. Franz operated his group of mines, known as the "Banner American group", and the Banner American 120-ton flotation mill from June 9 to December 1, 1934. The ore, a dry silver ore, was mined from open stopes, hoisted through a 60-foot vertical shaft on the K. C. claim, and transported by trucks to the mill, a distance of 1 mile. The mill was not operated at capacity. The product was silver-lead concentrates containing some gold, zinc, and copper; the zinc was lost at the Leadville smelter. Gold-silver ore was shipped to the Leadville smelter from the Wanakah-American Nettie group, operated by the American Lease until May 1 and by the McCullough Lease from May 1 to December 31. Small test lots of gold ore were shipped to smelters from several claims.

PARK COUNTY

Alma Placers district.—The glacial moraine area on the South Platte River east of Alma, commonly known as the "Alma Placers", was actively placered during the summer and fall of 1934 by miscellaneous lessees of small plots of ground, using principally sluice boxes, cradles, and pans. One operator tried out equipment consisting of a gasoline-propelled drag line, run by a Ford engine, and a concentrating table but reported that the venture was unsuccessful because the drag line failed to reach bedrock. The total output of gold from this property in 1934 was 1,046.04 fine ounces, the aggregate of deposits at the Denver Mint and sales of small lots to dealers by 94 people.

Beaver Creek district.—Placer gold was produced in 1934 by hydraulicking at the Shelton placer and by sluicing operations at several other placers along Beaver Creek.

Buckskin district.—In 1934 the Summit Mining Co. built a 40-ton flotation mill in Buckskin Gulch; it was operated 4 months on ore transported on a 4,200-foot aerial tramway from the company's Kentucky-Belle mine. The concentrates made were shipped to the Leadville smelter. The property was closed in November. Smelting ore was shipped to the Leadville smelter from the Excelsior, Loveland Mountain group, and Phillips mine. The Excelsior and Phillips mines also produced some ore that was sold to the Golden Cycle mill at Colorado Springs. A small quantity of gold bullion was shipped from the Paris mine. Sluicing operations along Buckskin Creek, chiefly at the Gold Bug mill site 2 miles from Alma, yielded a little placer gold.

Consolidated Montgomery district (Alma).—In 1934 small shipments of ore were made from the Liberty Boy group, Dolly Varden, Kansas, Morning Star, Prince Albert, and Republic mines to the Leadville smelter; a small shipment of gold ore was made from the Magnolia mine to the Golden Cycle mill; and 3.95 ounces of specimen gold were produced at the Saginaw lode. One small placer operation produced a little gold.

Fairplay district.—Placer gold was produced in 1934 by hydraulicking and drift mining at the property of the South Park Dredging Co. and by small sluicing operations at the Snowstorm and various other placers near Fairplay.

Hall Valley district (Webster).—A small shipment of gold-silver ore was made from the Missouri mine to the Golden Cycle mill in 1934.

Mosquito district.—In 1934 the Mosquito district ranked second among the Colorado districts in output of gold and first in output of lead. The London Gold Mines Co. operated the 125-ton London mill on ore from the South London and London Extension mines continuously throughout the year. The company shipped high-grade gold ore containing silver, copper, and lead to the Golden Cycle mill and lead concentrates, with the principal value in gold, to the Leadville smelter. The American mine and 100-ton flotation mill were active most of the year, operations being interrupted in May by a fire that destroyed the hoist, compressor house, and blacksmith shop. The mill produced gold-silver-copper-lead concentrates which were shipped to the Leadville smelter. The Fairplay Gold Mines, Inc., operated the "North London" mine 332 days and the flotation-gravity concentration mill (capacity on Mar. 1, 1935, 100 tons in 24 hours) 292 days during 1934. A 3,600-foot aerial tramway is used to bring the ore to the mill. Concentrates made are shipped to the Leadville smelter. Tailings from an old mill site on the Briscoe Ranch, where ore from the London mine was formerly treated, were shipped to the Golden Cycle mill at Colorado Springs. The London Mountain Gold Mining Co. shipped 162 tons of crude gold ore, extracted from its leased claims reached through the Oliver Twist tunnel, and nearly completed a 150-ton concentration mill at the portal of the tunnel. The Butte and West London mines were important producers of gold ore containing lead and silver. Other producers of 1 car or more of ore were the Archibald, Ophir, and Orphan Boy. Test work with a mechanical gold separator on 100 cubic yards of material from the Pennsylvania Mountain placer on the east slope of the mountain yielded some gold, most of which was not sold during the year.

Tarryall district.—The bulk of the gold output of the Tarryall district in 1934 came from the Peerless Mining Co. operation, begun in July and continued to November 6, on the Wilson placer in Park Gulch 7 miles southeast of Como. The apparatus used consisted of a feed hopper, feed conveyor, revolving screen, tailing stacker, 4 Ainlay centrifugal 36-inch bowls, and a centrifugal pump, all mounted on a movable steel frame, and a 1¼-yard gasoline power shovel. About 40,000 cubic yards of gravel were handled, and 707 crude ounces of bullion 0.930 fine in gold were recovered. Other operating placers, some of which used excavating machinery but all of which had small yields in 1934, included the Fortune, Melcord, Nila May, and Roberts. Small lots of gold ore were shipped from the Bob Harris and Sunnyside lode claims.

PITKIN COUNTY

Independence district.—Lessees at the Independence mine made a small output of gold ore in 1934.

Roaring Fork district (*Aspen*).—The Midnight 50-ton flotation mill was operated continuously but not at full capacity in 1934 on dry silver ore from the Midnight mine; the ore also contained lead, zinc, and a very small percentage of copper. Most of the silver was recovered in the lead concentrates made and sold to the Leadville smelter. Some high-grade silver-lead ore was shipped crude to the Leadville smelter. Zinc concentrates made in the new zinc unit added to the mill in 1933 were shipped to the zinc smelter at Amarillo, Tex. During 1934 the Colorado-Duluth Mining Co. leased the properties of the Smuggler Leasing Co. (Durant group), Della S Consolidated Mines Co. group, Percy La Salle Mining & Power Co. group, and Spar Consolidated Mines Co. group, comprising in all 127 claims or parts of claims and mill sites. The company did much new development work in addition to clearing and retimbering 11,120 feet of old workings and a 732-foot caved shaft. No ore was shipped on company account during the year, but individuals subleasing blocks around old stopes shipped some crude silver ore from the Aspen, Compromise, and Durant mines. One car of silver ore was shipped from one other property.

RIO GRANDE COUNTY

Summitville district.—In 1934 the Summitville Consolidated Mines, Inc., built a 100-ton flotation-cyanidation mill at the Little Annie group, constructed a 25-mile power line to it from Del Norte, and did development work in the mine. The flotation-concentration section of the mill was begun October 20 and the cyanide section the last week in November. The heads of ore into the mill in 1934 averaged 0.365 ounce gold and 1.0 ounce silver per ton. The yield from the 5,675 tons treated was 297 tons of gold concentrates averaging 3.93 ounces gold and 7.8 ounces silver per ton. In addition, flotation tailings cyanided yielded precipitates containing 33.77 ounces of gold and 75.30 ounces of silver. The only other producing mine in the Summitville district in 1934 was the Esmond, from which 1 car of gold ore was shipped to the Golden Cycle mill.

ROUTT COUNTY

Hahns Peak district.—The Hahns Peak Gold Mining & Milling Co. repaired surface buildings and underground timbering, cleaned out rock slides at its mines, and shipped a 2-ton test lot of gold-silver ore to the Golden Cycle mill at Colorado Springs in 1934. The placer gold produced in the Hahns Peak district was washed out of Ways Gulch south of Grouse Mountain by prospectors during the summer and fall.

SAGUACHE COUNTY

Blake district (Mirage).—At the Maid of Orleans-New Deal claims on Cotton Creek a lessee repaired a 3-ton gravity-concentration mill, using a water wheel for power, and operated it intermittently during the summer of 1934 as an experimental unit for testing the ores found during development work; in addition, a test lot of ore which contained gold and some silver was shipped crude to the Golden Cycle mill. As there was no other producing mine in the Blake district in 1934 and the operator does not wish the results of his tests published, the outputs from this district and the Music district have been combined for publication in the preceding table by districts.

Crestone district.—A small lot of gold ore was shipped from the Golden Hope mine to the Midvale (Utah) smelter in 1934.

Kerber Creek district (Bonanza).—A 1-ton lot of dry silver ore was shipped in 1934 to the Leadville smelter from the California claim, and small lots of lead ore were shipped from the Empress and Whale claims.

Music district.—Test runs on ore that had been previously mined and stored were made in 1934 at the Golden Treasure group in the 25-ton amalgamation-concentration mill on the property. The resulting amalgamation bullion was sold to the Denver Mint, and the lead-copper concentrates made were shipped to the Leadville smelter.

Vulcan district.—Two small lots of amalgamation bullion, recovered by prospectors from the Blue Jay and one other prospect presumably in the Vulcan district, were shipped to the Denver Mint in 1934.

SAN JUAN COUNTY

Animas district.—The bulk of the output of metals from San Juan County since 1931 has come from gold-silver ore containing copper and lead mined by the Shenandoah-Dives Mining Co. at its group of mines 4 miles easterly from Silverton and milled in its 600-ton flotation mill on the Animas River about 1½ miles from the mines. In 1934 the company milled 209,703 tons of ore yielding 8,102 tons of gold-silver-copper-lead-[zinc] concentrates which were sold to the Leadville smelter. Lead-silver-gold-copper ore was shipped from the North Star-Sultan, Pride of the West, and Royal Charter mines to the Leadville smelter. One car of silver-lead ore was shipped from the Little Fannie-Philadelphia group. High-grade gold ore extracted from the Delano Extension mine was sorted and crushed by hand and the gold recovered by amalgamation. Clean-up operations at the Silver Lake mill yielded gold by amalgamation. A 10-ton lot of lead-silver ore was shipped from the Emerald mine by a lessee. Two small shipments of ore, presumably test lots from prospects, were made from the Animas district by individuals, and one small lot of amalgamation bullion was shipped to the Denver Mint from an unidentified property. Placer gold was produced by sluicing operations on the Animas River and Mineral Creek.

Eureka district.—Producing mines in the Eureka district in 1934 were the Brooklyn, Eureka, Robert Bonner group, Silver Ledge, and one other mine. The zinc produced came from ore shipped to the United States Smelting, Refining & Mining Co. plant at Midvale, Utah, from the Robert Bonner group.

SAN MIGUEL COUNTY

Iron Springs district (Ophir).—No reduction plant was operated in the Iron Springs district in 1934, but some crude ore was shipped to smelters at Midvale and Tooele, Utah, and at Leadville, Colo., from the Carbonero, Carribeau, Montezuma, New Dominion, Pyramid, San Bernardo, and Santa Cruz mines. Lessees at several other properties recovered gold bullion from sorted high-grade ore found in pockets and reduced by hand.

Lower San Miguel district (Sawpit, Vanadium).—Placer gold was produced in 1934 from small sluicing operations along the San Miguel River and its tributaries.

Mount Wilson district.—One ton of gold ore from the Silver Pick mill, presumably a clean-up, was shipped in 1934 to the Golden Cycle mill at Colorado Springs, and a small sluicing operation on tailings near the Silver Pick mine yielded a little placer gold.

Upper San Miguel district.—The Smuggler-Union mine and 200-ton amalgamation-gravity and flotation concentration mill at Pandora were closed in February 1934 on account of a fire which necessitated renewal of the entire crushing plant. The mine was reopened in June and the mill in August, and both were operated continuously during the rest of the year. In May the San Juan Metals Corporation took over operation of the 500-ton mill, built in 1933 by the Gold Run Mining & Milling Co. for the treatment of an accumulation of tailings from old mills in the Upper San Miguel district, and produced and shipped gold concentrates to smelters from June through November. Other important producers were the Atlas, Black Bear, Liberty Bell, Lucky Strike (small milling operation on old tailings), and Laura mines. Gold bullion was produced from small-scale operations at various old mines in the district from very high-grade ore found in small kidneys and narrow fissures and treated with mortar and pestle or other types of small hand pulverizers. Sluicing operations along the San Miguel River below Telluride yielded small lots of placer gold, and panning of abandoned mine dumps yielded small lots of bullion.

SUMMIT COUNTY

Breckenridge district.—The Breckenridge district has produced more placer gold than any other district in Colorado and is the only district in the State in which floating dredges have continued to operate since the closing of the South Park dredge at Fairplay in 1925 and the Derry Ranch dredge in Lake County in 1926. Two dredges, both electrically driven, were active in 1934, one operated by the Continental Dredging Co. about 1½ miles north of Breckenridge in Blue River Valley and the other by the Tiger Placers Co. on Blue River through the town of Breckenridge. The dredge of the Continental Dredging Co. has a capacity of 4,000 cubic yards a day and is equipped with 98 buckets, each with a capacity of 7½ cubic feet; it was operated from January 1 to March 12, May 26 to September 20, October 2 to December 11, and December 22 to 31, handling about 682,000 cubic yards of gravel. The Tiger Placers Co. dredge has a capacity of 5,000 cubic yards a day and is equipped with 82 buckets, each with a capacity of 9½ cubic feet; it was operated continuously, except for time required for repairs, and handled 809,787 cubic yards of gravel. At the Bemrose-Bostwick hydraulic placer in Hoosier Gulch near Hoosier Pass about 4,000 cubic yards of gravel were handled during a period of 5 weeks, and 61.6 ounces of bullion averaging 0.817 fine in gold and 0.179 fine in silver were recovered. The Beaver Head, Jerusalem, and Yuba Dam placers were hydraulicked, and numerous small sluicing operations were carried on at other placers. The metal output from lode mines in the Breckenridge district came chiefly from gold-silver-lead ore shipped to the Leadville smelter from the Royal Tiger and two other properties and small lots of gold-silver-copper ore from the Jumbo mine. Lessees on the Royal Tiger also shipped some gold-silver ore to the Golden Cycle mill. Several lots of 1 ton or less, presumably test lots from prospects, were shipped to the Leadville smelter.

Montezuma district.—In 1934 a 27-ton lot of lead-silver ore was shipped from the Bullion group and a 7-ton lot, also lead-silver ore, from the Hunki Dori mine. The other output of the Montezuma district was gold-silver ore shipped from two unidentified properties.

Ten Mile district (Frisco, Kokomo, Robinson).—The Excelsior mine (at Frisco) was operated from January to September 1934 and produced 308 tons of gold-silver ore, the bulk of which was sold to the Leadville smelter. The Boston mine (at Kokomo) produced 144 tons of ore containing 39.53 ounces of gold, 978 ounces of silver, and 47,814 pounds of lead; the Gold Crest (at Kokomo), 25 tons of hand-picked ore containing 36.53 ounces of gold and 84 ounces of silver; and the Frisco Lode (at Frisco), 10 tons containing 4.07 ounces of gold. Small lots of gold-silver-lead ore were shipped to the Leadville smelter from prospects.

At the Buffalo placers near Dillon in 1934 the gravels were tested and ditches redug, and equipment including 10 hydraulic giants and a gasoline-driven power shovel was installed and made ready for operation in 1935. The McNulty Placers, Inc., moved a dry-land dredge to McNulty Gulch near Kokomo, but work in 1934 was confined chiefly to setting up the machinery and stripping the overburden. Small sluicing operations on Ten Mile Creek and in McNulty Gulch yielded a little gold.

TELLER COUNTY

Mine and dump siliceous sulphotelluride gold ores from the Cripple Creek district in 1934 aggregated 425,242 tons yielding in calculated recovered metals 127,901.20 fine ounces of gold and 12,555 fine ounces of silver compared with 349,470 tons yielding 109,815.36 ounces of gold and 7,700 ounces of silver in 1933. In these calculations account is taken of mill slags, clean-ups, and stolen specimen gold. Such accounting has been made in all previous reports of this series (Mineral Resources and Minerals Yearbook) and in United States Geological Survey Professional Paper 138. Placer methods recovered 48.70 fine ounces of gold and 1 fine ounce of silver in the district in 1934.

In 1934 the Golden Cycle mill at Colorado Springs (operations described under El Paso County) continued to hold the exclusive market for Cripple Creek ores. The treatment rates for the Cripple Creek district and for miscellaneous ores from other districts, effective September 1, 1933, were published in Minerals Yearbook, 1934, pages 184–187. The basis of these rates was not changed in 1934, but the settlements increased with the increase in the Government price for gold.

MINES REVIEW

Besides stimulating activity at going mines in the Cripple Creek district the increased price received for gold in 1934 over previous years resulted in repairs being made to shafts and surface equipment, in resumption of underground development and mining operations at many old properties, and also in the marketing of dump material of lower grade than in 1933. The two largest producers were the Cresson Consolidated Gold Mining & Milling Co. and the mines of the United Gold Mines Co., the latter an operating and holding company for property (including the Portland, acquired in 1933) scattered throughout the Cripple Creek district.

The annual report of the Cresson Consolidated Gold Mining & Milling Co. for the 12 months ended December 31, 1934 (dated Feb. 15, 1935), says:

During the 12 months 54,749 dry tons of ore were shipped on company account of a gross value of $630,238.17, averaging $11.50 per ton; the returns, less transportation and treatment of $247,110.19, were $383,127.98, giving the ore a net value of $7.00 per ton. The company received as additional income the sum of $3,518.31 interest on bank deposits and $211,107.98 net royalty on 42,543 tons lessee ore, making a total of $597,754.27, with total expenses of $360,303.95, resulting in a net gain from operations of $237,450.32.

The operations of lessees through the Cresson shaft were on a split check lease, that is, 50 percent to company and 50 percent to lessee, after deducting freight and treatment. The increased price of gold has permitted us to develop and ship a grade of ore which heretofore could not be marketed at a profit. Increased development work and dividends resulted. The mine has more ore reserves than a year ago, but it is difficult to estimate them owing to conditions which in the Cripple Creek district cut off the ore. New work is the only thing to insure the life of the mines.

Development

	Feet
Drifts and crosscuts:	
Company	6,444
Lessees	2,769
	9,213
Raises and winzes:	
Company	1,162
Lessees	1,068
	2,230
Total	11,443

Development work the past year has resulted in the opening of a number of bodies of ore, and there is more ore in sight at the present price of gold than a year ago. Three fairly large ore bodies are now being stoped on the 11th, 14th, and 15th levels. These stopes should yield a good tonnage of ore of average value. Smaller bodies of ore have also been opened on the 3rd, 10th, 12th, 13th, and 17th levels. Development on these has not progressed far enough to determine their value or size.

There are 29 sets of lessees operating on the split check system, working on various blocks of ground, through the Cresson shaft. Most of these lessees are shipping some ore. The lessees, during the past year, have yielded the company a substantial profit, and the company should receive considerable revenue from this source during the year 1935.

Operating costs have increased, due to higher costs of supplies and labor.

The average cost per ton of ore produced by company and lessees was $3.70 on total of 97,292 tons.

	Per ton
Federal taxes	$0.260
Taxes	.060
Insurance	.136
Salary officers	.030
Colorado Springs office	.059
Mining operations (includes mine management and engineering)	3.140
General	.015
	3.700

Production of the Cresson Consolidated Gold Mining & Milling Co., Colorado, 1903 to Dec. 31, 1934

Period	Dry short tons	Gross value	Freight and treatment	Net value
1903 to Dec. 31, 1933	2,122,298	$35,331,783.95	$10,826,914.15	$24,504,869.80
1934:				
Company ore	54,749	630,238.17	247,110.19	383,127.98
Lessee ore	42,543	623,698.09	217,585.51	406,112.58
1903 to Dec. 31, 1934	2,219,590	36,585,720.21	11,291,609.85	25,294,110.36

Period	Royalties received by company	Amount paid lessees	Average gross value per ton	Average net value per ton	Dividends
1903 to Dec. 31, 1933			$16.65	$11.54	$12,454,472.50
1934:					
Company ore			11.50	7.00	158,600.00
Lessee ore	$211,107.98	$195,004.60	14.66	9.52	
1903 to Dec. 31, 1934			16.48	11.40	[1] 12,613,072.50

[1] Represents 34.48 percent of the gross value and 49.86 percent of the net value.

The annual report of the United Gold Mines Co. for the 12 months ended December 31, 1934 (dated Mar. 30, 1935), says:

During the year 25,116 feet of development work was done, compared with 14,486 feet in 1933. This additional development, together with the increased price of gold, has made a large amount of ore available for shipment.

All the plants and equipment of the company have also been improved. Fire destroyed the headframe, ore house, and engine room at the Theresa shaft. To avoid this danger in the future and the fact that a large amount of low-grade ore was developed, it was decided to put in steel headframe and ore bins, with arrangement that requires almost no top labor. Also a two-car skip was installed. The railroad track was changed so more cars could be set for loading. This installation cost more but is the best and most economical ore house ever built in the district.

The property is nearly all leased or being worked on company account.

The Portland property was taken over to satisfy advances made by your company. The Portland has a large number of lessees, but the development has been disappointing; even under new price of gold its earnings about equal expense.

A few adjoining claims have been acquired through purchases of tax certificates. Your company owns 1,667 acres in the Cripple Creek district.

The new price of gold will result in development which we believe will open a large amount of ore.

Total production of property—United Gold Mines Co.

	Net tons	Gross value
Ore mined before consolidation	26, 310	$456, 806. 19
Production under operations of the United Gold Mines Co	1, 191, 858	13, 246, 753. 75
Total to Dec. 31, 1934	1, 218, 168	13, 703, 559. 94

Production of the United Gold Mines Co.—Company ore in 1934

Mine	Net tons	Gross value	Company ore cash receipts	Average gross value per ton	Number of cars shipped
Vindicator	8, 558	$32, 502. 59	$9, 639. 78	$3. 80	245
Theresa	529	1, 895. 44	486. 47	3. 58	18
Rose Nicol	7, 260	143, 847. 34	100, 994. 11	19. 81	179
Portland	93	376. 59	155. 56	4. 06	2
Fairview	18	172. 71	72. 80	9. 50	1
	16, 458	178, 794. 67	111, 348. 72	10. 86	445

Production of the United Gold Mines Co.—Lessee ore in 1934

Group	Net tons	Gross value	Royalties received	Lessees' receipts	Average gross value per ton	Number of cars
Deadwood group:						
Findley	3, 540	$15, 373. 34	$961. 87	$4, 323. 41	$4. 34	95
Shurtloff	539	5, 181. 33	454. 87	2, 395. 90	9. 62	13
Miscellaneous	14, 797	110, 930. 39	10, 699. 09	40, 629. 35	7. 50	452
Londonderry group:						
Solomon	1, 139	17, 485. 42	2, 086. 18	8, 280. 94	15. 35	34
Miscellaneous	3, 337	17, 147. 60	737. 75	4, 506. 40	5. 14	94
Bonanza group	3, 509	76, 673. 87	10, 643. 49	40, 063. 85	21. 95	104
W. P. H. group	1, 274	10, 163. 34	652. 18	3, 993. 39	7. 98	31
Hardwood group	803	5, 294. 03	466. 32	1, 919. 82	6. 59	24
Fairview group	55	332. 87	66. 14	61. 02	6. 07	2
Vindicator	26, 862	302, 262. 74	90, 393. 19	98, 224. 95	11. 25	779
Theresa	8, 424	94, 582. 33	18, 842. 93	36, 043. 00	11. 23	251
Rose Nicol	4, 019	36, 270. 96	4, 467. 66	15, 416. 60	9. 03	116
Portland	9, 593	110, 493. 90	29, 140. 49	35, 480. 24	11. 52	314
Last Dollar	12, 481	95, 167. 47	24, 430. 62	25, 234. 58	7. 63	367
Independence	1, 436	10, 478. 54	2, 224. 43	2, 796. 63	7. 30	49
	91, 808	907, 838. 13	196, 267. 21	319, 370. 08	9. 89	2, 725

Data for the following table were taken from annual reports for 1934 issued by the three companies named.

Production in 1934

Company	Net tons	Gross value	Royalty	Lessees	Average gross value per ton
Dr. Jack Pot Mining Co	6, 921	$35, 193. 80	$2, 289. 50	$11, 372. 49	$5. 084
New Gold Dollar Mining Co	3, 794	30, 141. 37	2, 378. 08	11, 810. 31	7. 944
The Elkton Co	8, 377	46, 984. 96	3, 183. 18	16, 668. 40	5. 610

The Colorado International Mining Corporation, which purchased the Granite group in 1933, early in 1934 completed a crosscut from the Portland No. 2 shaft at the Roosevelt Tunnel altitude for drainage purposes, pumps being installed at the crosscut level near the Ajax shaft; production in 1934 was 28,239 tons, mostly from below the water level. Lessees on 20 mines or dumps owned by the Stratton-Cripple Creek Mining & Development Co. produced and shipped 24,265 tons of mine and dump ore. The New Zealand Gold Mining Co. shipped 6,341 tons of ore from the new ore body opened up in the Joe Dandy mine. The Hidalgo Gold Mines, Inc., purchased a controlling interest in the El Paso group of mines, which it reopened and from which it shipped 4,420 tons during the year; it made additional output from the Hull City (United Gold Mines Co.) and Victor (Smith-Moffat Mines Co.) mines, operated under lease. The Empire Lee Mining Co. made a substantial output of gold from shipments of dump ore.

The operations which have been described in the foregoing pages on Teller County yielded 71 percent of the total tonnage output of the Cripple Creek district in 1934.

Other important producers were the Acacia Gold Mining Co. (Morning Star and North and South Burns), Adney Grant, Atlas Gold Mines Co. (Midget-Bonanza King), Buckeye Mines & Milling Co., Commonwealth Gold, Inc., Cripple Creek Coalition (dump), Economic mill dump, Forest Queen, Free Coinage Gold Mining Co., Hildreth Frost properties (excluding Joe Dandy, already mentioned), International Gold Producers, Inc. (mainly from the Logan, included in Stratton Estate production), Jerry Johnson Gold Mining Co., LeClair Consolidated Mines Co. (Mary McKinney), Mexican Gold & Silver Mining Co. (Gold Pinnacle), Moose Mine Operation, Inc., Queen Gold Mining Co., Raven Apex, School Section 16, and Strong Mining Co. Bullion produced from hand treatment of specimens and high-grade ore from the district and from the treatment of oxidized ore by crushing and cyanide leaching at the Iron Clad mine aggregated 263.60 fine ounces of gold and was sold direct to the Denver Mint or to dealers in Denver.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN AND CENTRAL STATES

(MINE REPORT)

By J. P. Dunlop and H. M. Meyer

SUMMARY OUTLINE

Although the copper, lead, and zinc produced in the Eastern and Central States in 1934 and during many earlier years have greatly exceeded in value the recovered gold, attention during 1934 was centered largely on the gold deposits. This was natural as more copper, lead, and zinc can be obtained from existing developed mines than are needed for present requirements. As a result, efforts were directed toward the development of areas producing gold—a metal with an unlimited market at a price not dreamed of 2 years ago—and miners and investors alike have been attracted to the Southern Appalachian States. Gold recovered from mines in the Eastern States increased from 2,000 fine ounces in 1933 to 6,646 ounces in 1934.

Gold mining in the South has been dormant so long that few people remember the mines that yielded large quantities decades before gold was discovered in the present large producing areas of the West.

Michigan copper mines are well-known, but few persons know that Michigan has produced considerable gold from siliceous ore. Two of the old Michigan gold mines near Ishpeming have been unwatered, and the Calumet & Hecla Consolidated Copper Co. is actively developing the old Ropes gold mine.

Mines in North Carolina are credited with an aggregate output of gold exceeding 1,147,600 ounces, and those in Virginia are credited with a total of more than 160,290 ounces (nearly all produced prior to 1910). In the Southern Appalachian States not only was the output of gold in 1934 more than three times that in 1933 but many old mines were prospected and sampled. Pending development and experimental work few new mills were erected, but two new all-flotation plants treated more than 80 percent of the 41,232 tons of siliceous ore milled or smelted in 1934. Whereas in 1933 nearly all the gold produced in the Southern States was derived from placer bullion or was recovered in amalgamating mills, in 1934 more than half the gold output came from flotation concentrates shipped to smelters.

The gold deposits in North Carolina and South Carolina were examined in 1934 by the United States Geological Survey with funds allotted by the Public Works Administration.[1]

In North Carolina the area covered by the field survey lies within the Piedmont region in the west-central part of the State and includes parts or all of 15 counties from Anson and Union on the south to Guilford and Caldwell on the north. In South Carolina two gold-bearing areas in the Piedmont region were examined; one lies along the northern border and is a continuation of that in North Carolina, and the other is in the southwestern part of the State adjacent to Georgia. In the course of the work some 500 gold mines (old and new), of which more than 400 were in North Carolina, were mapped and the accessible workings examined; several reported deposits were not visited. Outside the area traversed other gold and copper mines are known in the Piedmont region and in the mountain districts of North Carolina.

It is hoped that enough money will be allotted by the Public Works Administration to extend the examination to the gold-mining areas in Georgia, Alabama, and Virginia.

Mines in the Eastern and Central States yielded metals in 1934 valued as follows: Gold, $234,342; silver, $108,863; copper, $5,487,-739; lead, $8,738,512; and zinc, $28,895,512. Gold, copper, lead, and zinc increased in both quantity and value over 1933; silver decreased in quantity but increased in value.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly United States Government prices.[2] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

[1] Pardee, J. T., Preliminary Report on Gold Deposits in North Carolina and South Carolina: P.W. 29021, Mar. 18, 1935, 43 pp.

[2] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

Salient statistics of mine production of gold, silver, copper, lead, and zinc in the Eastern and Central States in 1934, by States, in terms of recovered metals

State	Ore, old tailings, etc., sold or treated	Gold (lode and placer)		Silver (lode and placer)	Copper	Lead	Zinc	Total value
	Short tons	*Fine ounces*		*Fine ounces*	*Pounds*	*Short tons*	*Short tons*	
Eastern States:								
Alabama	22,511	2,780.71	$97,186	361	11,000			$98,299
Georgia	2,069	969.91	33,898	48				33,929
New Jersey	469,339						76,553	[1] 8,772,200
New York	282,952			26,406		(2)	23,188	[3] 2,011,239
North Carolina	26,770	508.70	17,779	9,710	(4)			[5] 24,056
Pennsylvania	557,740	623.00	21,774	6,230	(4)			[5] 25,801
South Carolina	3,982	642.03	22,439	487	400			22,786
Tennessee	1,412,626	455.00	15,902	61,148	[4] 20,322,800	[2] 3,625	[6] 47,712	[7] 6,052,738
Virginia	263,144	667.10	23,315	103	400	(2)	(6)	[8] 23,414
	3,041,133	6,646.45	232,293	104,493	20,334,600	3,625	147,453	17,064,462
Total, 1933	2,259,022	1,999.77	[9] 51,115	53,829	13,626,320	3,116	125,628	[9] 13,687,275
Central States:								
Arkansas	(10)					40	68	8,808
Illinois	(10)			310		40		3,160
Kansas	2,096,700					6,805	38,261	3,794,016
Kentucky	(10)					104	125	18,446
Michigan	[11] 700,055	58.63	2,049	[12] 529	48,215,859			3,859,660
Missouri	3,415,000			63,066	46,276	90,493	7,059	7,348,028
Oklahoma	5,927,400					16,747	107,772	10,507,670
Wisconsin	308,600					234	9,807	860,718
	[11] 12,447,755	58.63	2,049	63,905	48,262,135	114,463	163,092	26,400,506
Total, 1933	[13] 8,465,458	9.67	[9] 247	127,348	46,853,130	110,073	145,093	[9] 23,376,633

1 Estimated smelting value of recoverable zinc content of ore after freight, haulage, smelting, and manufacturing charges are added.
2 New York and Virginia included under Tennessee; Bureau of Mines not at liberty to publish separate figures.
3 Excludes value of lead, which is included under Tennessee.
4 North Carolina and Pennsylvania included under Tennessee; Bureau of Mines not at liberty to publish separate figures.
5 Excludes value of copper, which is included under Tennessee.
6 Virginia included under Tennessee; Bureau of Mines not at liberty to publish separate figures.
7 Includes also value of copper from North Carolina and Pennsylvania, lead from New York and Virginia, and zinc from Virginia.
8 Excludes value of lead and zinc, which is included under Tennessee.
9 Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).
10 No estimates available for small quantity of ore treated in Arkansas, Illinois, or Kentucky.
11 Excludes 800 tons of ore from Michigan amalgamated for recovery of gold and silver.
12 According to Bureau of the Mint.
13 Excludes 200 tons of old tailings from Michigan cyanided for recovery of gold and silver.

Gold and silver.—The output of gold in the Eastern States was 6,646.45 fine ounces in 1934, or 4,646.68 ounces more than in 1933. The yield from placer mines increased from 663.37 fine ounces in 1933 to 874.34 ounces in 1934; gold derived from siliceous ore increased from 712.41 to 4,494.11 ounces, and that from the refining of copper bullion from 623.99 to 1,278 ounces. Yields of gold in 1934 were reported from 43 placers and 31 lode mines; the number of lode-gold producers nearly doubled. One mine in Alabama and one in Virginia produced more than half the gold recovered in the Eastern States; few of the new mines or of the old mines reopened made any large output, as most of the work was experimental. The estimated output of gold in the Southern Appalachian States from 1799 to 1934, inclusive, is recorded as 2,486,703.89 fine ounces valued at $51,490,736; little has been produced in recent years. In 1933 only 2,869 tons of siliceous ore were treated, of which 2,619 tons were amalgamated or cyanided and 250 tons were shipped crude to smelters; in 1934, 41,232 tons of siliceous ore (from mines in Alabama, Georgia, North Carolina, South Carolina, and Virginia) were treated, of which 6,319 tons were treated at gold and silver mills (mainly by amalgamation), 302 tons (mostly from South Carolina) were shipped crude to smelters, and 34,611 tons were sent to all-flotation mills and yielded 1,265 tons of gold concentrates which were shipped to smelters. These gold concentrates yielded 3,467.84 ounces of gold, whereas bullion from gold milling plants yielded only 662.45 ounces (about two-thirds as much as was derived from flotation copper concentrates smelted) and the crude siliceous ore smelted yielded 363.82 ounces.

Michigan was the only one of the Central States to produce gold in 1934; its yield (58.63 ounces) was from the experimental treatment of ore from an old mine at Ishpeming which was unwatered after a long period of idleness.

Of the silver (104,493 ounces) produced in the Eastern States in 1934 all except 96 ounces from placer bullion and 1,113 ounces from lode-gold mines was derived from copper bullion recovered from copper ore and copper concentrates from mines in North Carolina, Pennsylvania, and Tennessee and from lead bullion from a mine in New York. The increase (50,664 ounces) in the silver output of the Eastern States was due almost entirely to the larger output of copper and lead.

Production of silver in the Central States in 1934 totaled 63,905 ounces. The small output in Illinois came from galena concentrates recovered in milling fluorspar; that in Michigan was from copper ore and siliceous ore; and that in Missouri (63,066 ounces) was derived from bullion from lead ore. No copper ore or zinc concentrates containing silver were shipped in 1934.

Copper.—The mine production of copper in the Eastern States was 20,334,600 pounds valued at $1,626,768 in 1934 compared with 13,626,320 pounds valued at $872,084 in 1933. Each of the large producing States—North Carolina, Pennsylvania, and Tennessee—showed an increase in value of output, but the Bureau of Mines is not at liberty to show their production separately. The copper was derived from copper ore mined in North Carolina and Tennessee, from gold concentrates shipped to smelters from Alabama, South Carolina, and Virginia, and from copper concentrates recovered from Pennsylvania pyritiferous magnetite ore mined for its iron content. The output of copper from the gold concentrates was 11,800 pounds. The copper ore yielded about 0.001 ounce gold and 0.11 ounce silver to the ton of crude ore. The copper concentrates from the magnetite ore contained about 23 percent copper and about 0.10 ounce gold and 1 ounce silver to the ton.

The copper output of the Central States in 1934 came from copper ore from Michigan and lead ore from Missouri; no copper ore was shipped from Missouri. The output of refined copper in Michigan increased from 46,853,130 pounds in 1933 to 48,215,859 pounds in 1934 and the average recovery per ton of rock treated from 67.2 to 68.9 pounds.

Lead.—The lead produced from mines in the Eastern States in 1934 came from lead-zinc ores from the Austinville mine in Virginia, the Balmat mine in New York, and the Embree mine in Tennessee.

Shipments of galena concentrates amounted to 5,939 tons and yielded 3,625 tons of lead, or 509 tons more than the yield in 1933.

The lead recovered from shipments of lead ore and concentrates from mines in the Central States increased from 110,073 tons in 1933 to 114,463 tons in 1934, due mainly to shipments from mines in southeastern Missouri. Missouri shipments yielded 90,493 tons of lead in 1934 compared with 84,980 tons in 1933, of which 89,580 tons in 1934 and 83,970 tons in 1933 were from mines in southeastern Missouri. Recovered lead in shipments from Oklahoma mines totaled 16,747 tons in 1934 and 18,038 tons in 1933, and shipments of lead concentrates from Kansas mines yielded 6,805 tons of lead compared with 6,089 tons in 1933; in both 1934 and 1933 the mines in Oklahoma and Kansas produced more lead than was shipped, and stocks of galena concentrates at mines exceeded 16,000 tons at the end of 1934. Wisconsin mines produced ore yielding 234 tons of lead in 1934 compared with 540 tons in 1933. Lead concentrates from Illinois mines yielded 40 tons of lead in 1934, lead concentrates and lead-zinc ore from Kentucky 104 tons, and lead concentrates from Arkansas 40 tons. Mines in the Tri-State or Joplin region shipped 31,897 dry tons of lead concentrates yielding 24,465 tons of lead, or slightly less than the lead yield in 1933.

Zinc.—The recoverable zinc in ore and concentrates shipped from mines in the Eastern States was 147,453 tons valued at $14,869,600 in 1934 compared with 125,628 tons valued at $12,514,652 in 1933. Mines in New Jersey yielded more than 76,000 tons, as metal or in oxide, in 1934 valued at $8,772,200.

[N. B.—The value of the zinc in New Jersey is not that of ore mined. It is the estimated smelting value of the recoverable zinc content of the ore after freight, haulage, smelting, and manufacturing charges are added.]

Mines in New York shipped concentrates in 1934, partly from zinc ore and partly from lead-zinc ore, from which 23,188 tons of zinc were recovered. Zinc sulphide ores yielded nearly all the zinc from Tennessee, and all the ore was concentrated except a small quantity of zinc carbonate. The recovered zinc output and the shipment of zinc concentrates from mines in Virginia may not be disclosed, but the recoverable zinc content of concentrates shipped from Tennessee and Virginia was 47,712 tons. All zinc concentrates shipped were sphalerite except 5,491 tons of zinc carbonate from Tennessee.

Shipments of zinc concentrates from mines in the Central States had a recovered zinc content of 163,092 tons in 1934 compared with 145,093 tons in 1933. Mines in the Tri-State region shipped ore and concentrates yielding 153,092 tons of zinc in 1934 (137,054 tons in 1933), of which Oklahoma contributed 70.4 percent and Kansas 25 percent. Stocks of sphalerite were comparatively small at the end of 1934. The zinc recovered from Wisconsin mine shipments totaled 9,807 tons in 1934 and 7,800 tons in 1933 and that from mines in Missouri 7,059 tons in 1934 and 5,042 tons in 1933. No Illinois mines shipped any zinc in 1934, and shipments from Arkansas contained only 68 tons of recoverable zinc. Kentucky mines shipped zinc carbonate concentrates and lead-zinc ore containing 125 tons of recoverable zinc.

MINE PRODUCTION IN THE EASTERN STATES

Alabama.—The quantity of gold produced in Alabama from 1830 to 1934, inclusive, is recorded as 39,996.13 fine ounces. The yield in 1934 was 2,780.71 ounces, or nearly as much as the combined output of Georgia, North Carolina, South Carolina, and Virginia. There was a small placer production, but the gold output of the State was mainly that of the Hog Mountain Gold Mining & Milling Co. in Tallapoosa County about 15 miles from Alexander City, which mined and milled more gold ore in 1934 than has been produced in the Southern States for many years. The Hog Mountain mine was discovered in 1839; its total production of gold is not known, but its yield from 1893 to 1915, inclusive, is estimated at about $250,000. It was operated throughout 1934. The mine is opened by a 215-foot shaft; about 2,000 feet of drifts were run in 1934—1,500 feet on the 100-foot level and 500 feet on the 200-foot level. The sulphide ore is treated at the 150-ton all-flotation mill first operated in February 1934. The crude ore contains about 0.179 ounce of gold to the ton and traces of silver, copper, and zinc; the concentrates, which were shipped to the Nichols Copper Co., yielded about 2.64 ounces to the ton. Changes are being tried in the flow sheet of the mill. The flotation concentrates turn to a hard, red clinker after being dried.

Georgia.—The quantity of gold produced in Georgia from 1830 to 1934, inclusive, is recorded as 865,478.65 fine ounces. In 1934, 20 placers and 7 lode mines yielded a total of 969.91 ounces of gold and 48 ounces of silver. Of the 542.50 ounces of placer gold produced, 147.74 ounces came from placers near Dahlonega and Auraria in Lumpkin County, 325.84 ounces from mines in White County, and the remainder (68.92 ounces) from small mines operating in Cherokee, Dawson, Forsyth, Gwinnett, Hall, and Paulding Counties. The largest placer producers were T. J. Stevenson, Dixie Gravel Co., Topabri, Inc., J. C. McDonald, and the Zamoda Corporation. Gold recovered from siliceous ore in 1934 amounted to 427.41 ounces, most of which was produced by the Southern Mineral Development Co., the 301 Mining Co., and W. H. Fluker.

The Childs placer near Sautee, White County, operated by T. J. Stevenson, was the largest producer of placer gold; the Dukes Creek placer near Helen, White County, operated by the Dixie Gravel Co., ranked second. The following mines in Lumpkin County reported placer yields: Topabri, McDonald, Crown Mountain, Etowah, Calhoun, Christian, Center Creek, and Christie.

The Hamilton and Columbia mines and 5-stamp mill at Thomson, McDuffie County, were operated by W. H. Fluker; the shaft at the Hamilton mine was deepened, and the small production was from ore milled for tests. The 301 Mining Co. near Hollysprings in Cherokee County sank a 135-foot shaft and ran 200 feet of drifts. The ore taken out was treated by amalgamation and concentration, the bullion being shipped to the United States Mint at New Orleans and the concentrates stocked for future treatment. The Shelby mine and 5-stamp mill at Buford, Gwinnett County, were operated by Brown and Conroy a few weeks. The Southern Mineral Development Co. bought the Battle Creek mine at Dahlonega, Lumpkin County, early in 1934, cleaned the old workings, and deepened the shaft; a 10-stamp amalgamation concentrating plant was completed in November and considerable bullion was shipped, but all concentrates were held for further treatment. In Wilkes County near Rayle the Arnold mine, equipped with a 5-stamp mill, was operated about 10 days in 1934 by G. W. Bankston. The Cook mine in Fulton County was worked 3 months by W. L. Brown, and some bullion was shipped. Many properties in Lumpkin County changed owners, and preparations were made to reopen several old producers. The Barlow group of about 1,200 acres was optioned to Charles Cary. Options on the Findley, Turkey Hill, Cabbage Patch, and Chestatee mines were given by Craig R. Arnold. The Hand, Yahoola, Knight, McAfee, Mary Henry, and Banning mines have been grouped under ownership of the Arnold Consolidated Gold Mines, and it is stated that a mill will be constructed to treat ore mined at these properties and at other Dahlonega mines.

Maryland.—The total gold production of Maryland to the end of 1934 is estimated as 3,467.71 fine ounces. No gold or silver was produced in 1934.

New Jersey (see also note on p. 241).—The production of zinc ore in New Jersey in 1934 was 469,339 tons containing 76,553 tons of recoverable zinc. The only producing properties were the Mine Hill and Sterling Hill mines.

New York.—The quantity of zinc ore (84,016 tons) and that of lead-zinc ore (198,936 tons) milled in New York in 1934 were much larger than in 1933. The concentrates shipped yielded 23,188 tons of zinc and some lead; the lead concentrates also yielded considerable silver. The old Edwards mine yields sulphide zinc ore and is equipped with a 500-ton all-flotation plant, and the Balmat mine near Sylvan Lake produces lead-zinc ore and is equipped with a 700-ton all-flotation plant. The shaft at the Edwards is about 1,500 feet deep and that at the Balmat 500 feet deep.

North Carolina.—The quantity of gold produced in North Carolina from 1799 to 1934, inclusive, is recorded as 1,147,637.53 fine ounces. The yield in 1934 was 508.70 ounces, of which 218.26 ounces came from 14 placer operations and 290.44 ounces from 12 lode mines. The output of silver was 9,710 ounces. The Fontana copper mine was the largest producer of gold in the State, although its crude ore assays only 0.009 ounce gold to the ton. Placer gold was recovered in Burke, Cabarrus, Franklin, Guilford, Haywood, Mecklenburg, Montgomery, Randolph, Rowan, and Rutherford Counties; the larger producing placer properties were the Black Ankle at Seagrove in Randolph County and the Gardner Hill in Guilford County. All the lode-gold mines were comparatively small producers, and only 620 tons of gold ore were milled in 1934; one carload of gold ore was shipped to the Nichols Copper Co. All the copper ore was shipped to Copperhill, Tenn. The producing lode-gold mines were the Rudisill in Cabarrus County, operated by the Cabarrus Mining & Milling Co.; the Furnace in Cabarrus County, operated by Sam J. Furr; the Zachary in Jackson County; the Iola in Montgomery County; the State Center and the Gold Bowl in Randolph County; the Gold Hill dump in Rowan County; the Ellwood, the Flack, and the 1,000-Acre Tract in Rutherford County; and the Rogers in Union County.

The North Carolina Exploration Co. shipped crude sulphide copper ore from the Fontana mine in Swain County to the Tennessee

Copper Co. smelter at Copperhill, Tenn.; this ore is said to have an average content of 0.009 ounce gold and 0.068 ounce silver to the ton. The Snyder prospect near Mount Pleasant in Cabarrus County is under option to Shorey C. Guess; the shaft was unwatered and the drifts were cleaned out in 1934. The Gardner Hill mine in Guilford County was unwatered by the J. E. Latham Co.; the mine workings were mapped and ore samples assayed but the only gold recovered in 1934 was from sluicing the dump. Development was continued at the Kindley mine near Fullers in Randolph County; there is a 10-ton amalgamation and concentration plant on the property. The Gold Bowl mine in Randolph County is equipped with a 10-stamp amalgamation plant, and a small quantity of ore was milled in 1934. Karl Austerman shipped 1 car of sorted smelter slag and old table concentrates, enriched with some material recovered in experimental cyanidation of old dump ore, from Gold Hill in Rowan County. The Keystone Mining & Milling Co. treated some ore from the Ellwood and Flack mines in Rutherford County. The 1,000-Acre Tract near Union Mills in Rutherford County was under development by Carey W. Thompson, and some crude ore was milled at a 10-stamp mill. The old Parker mine in Stanly County was not operated in 1934, but later in the year it was acquired by the North Carolina Mining Corporation to be developed in 1935. The Iola dump at Candor in Montgomery County was worked by Claud Hafer, and some ore was treated at the ball mill. The Howie mine at Waxhaw in Union County was unwatered and sampled by the Candor Consolidated Mines, Ltd., of Toronto, Ontario. About 400 feet of drifts were run on the 250-foot level. There are several shafts and 3,000 feet of drifts on the property; the shafts were retimbered, and a compressor plant was installed. A power plant was built, and considerable diamond drilling done. The old 20-stamp mill, which has not been used for several years, is to be remodeled as soon as the method of treating the ore is determined.

Pennsylvania.—The Cornwall mines in Lebanon County were operated at a greatly increased rate in 1934, and more than 6,200 tons of copper concentrates were shipped. The ore mined is pyritiferous magnetite, and the tailings from the iron concentrates go to the flotation plant. The copper concentrates, which contained about 23 percent copper and about 0.10 ounce gold and 1 ounce silver to the ton, were shipped to the Nichols Copper Co.

South Carolina.—From 1829 to 1934, inclusive, mines in South Carolina yielded 251,689.02 fine ounces of gold. The output in 1934 from 5 placers and 7 lode mines was 642.03 ounces, of which 543.26 ounces came from the lode mines. Gold milling plants recovered 159.61 ounces of gold, concentrates shipped to smelters yielded 34.84 ounces, and crude ore shipped to smelters yielded 348.81 ounces. The lode mines also yielded 481 ounces of silver and 400 pounds of copper. The placer output of silver was only 6 ounces. The only large placer operated was that of the Brewer Mining Co. in Lancaster County near Jefferson; other placer mines were operated by J. C. Byers, Atkins & Briggs, and J. H. Hartman. Although no shipments of bullion were made in 1934 from the Haile mine in Lancaster County, the only important lode mine operated in 1933, 7 mines milled or shipped a total of nearly 4,000 tons of gold ore in 1934, and development was active for the first time in many years. T. A. Campbell shipped 1 car of crude ore from Blacksburg, Cherokee County, to the U.S. Metals Refining Co. at Carteret, N. J.

The Pioneer Mining Co. did 700 feet of development work at the Smith mine near McCormick; the mine is equipped with a 100-ton amalgamation concentration and flotation plant and some bullion was shipped in 1934, but the concentrates were stored for cyanidation. The Nott Hill Mining Co., Inc., produced a small quantity of bullion in a 10-stamp mill while prospecting and developing its mine in Union County near Pauline. The Bar Kat mine in Cherokee County near Smyrna was operated 11 months by James R. Elmendorf, and 3 cars of crude ore were shipped to the U.S. Metals Refining Co. The Terry mine, also at Smyrna, was under development by Shorey C. Guess; about 1,400 feet of drifts, etc., were run in 1934, and about 3 cars of crude ore were shipped. The White Star Mining Co. of Smyrna did not operate any mine in 1934 but milled custom ore. Its 50-ton flotation plant was built in 1934 and began operating in June; the amalgam made was not sold, but some flotation concentrates were shipped. Meyers & Austerman, of Hickory Grove, York County, treated old tailings from the Magnolia dump in a 50-ton cyanide plant and did development work in the Magnolia mine; some crude ore taken out was shipped to the Nichols Copper Co. Preparations for development were made at the old Haile mine in Lancaster County, near Kershaw. This mine was discovered in 1828 and probably has been the largest producer of gold in the Southern Appalachian States, its total yield being estimated at more than $3,200,000. The Dorn mine at McCormick, which is said to have yielded more than $900,000 in gold, was under development in 1934 by North America Gold Mines, Inc. The mine has a shaft 185 feet deep and about 700 feet of drifts and crosscuts on the 175-foot level. The main values of the ore are in gold, but it also contains some silver, lead, and zinc. The Landrum mine in Edgefield County was under development by the Southern Gold Mines Corporation; sampling is said to show an average gold content of 0.16 ounce to the ton of ore.

Tennessee.—Mines in Tennessee produced 18,142.88 fine ounces of gold from 1831 to 1934, inclusive; almost the entire output since 1906 has been from copper ore. No placer gold was marketed from Coker Creek in 1934, and the entire gold yield of the State came from copper bullion refined. There were increases in the output of gold, silver, copper, lead, and zinc from Tennessee mines in 1934 compared with 1933. Production of gold increased from 223.49 to 455.00 ounces and that of silver from 39,869 to 61,148 ounces. Tennessee produces little lead, and the output was only 44 tons more than in 1933.

The total copper produced from mines in Tennessee, North Carolina, and Pennsylvania was 20,322,800 pounds in 1934, an increase of 6,696,480 pounds over 1933; the increase in value of copper produced was shared by mines in all three States. The total lead recovered from mines in Tennessee, New York, and Virginia in 1934 was 3,625 tons. The total zinc recovered from mines in Tennessee and Virginia was 47,712 tons. The Bureau of Mines is not at liberty to publish figures for the foregoing States separately.

The Tennessee Copper Co. ran its flotation plant and smelter on ore from its Burra-Burra mine in Tennessee and on sulphide ore from the Fontana mine in Swain County, N. C. The Burra-Burra mine was operated 261 days and the 1,200-ton flotation plant 306 days. The zinc concentrates were shipped to the American Steel & Wire Co., Donora, Pa., and the copper bullion was shipped to the Nichols Copper Co. The Ducktown Chemical & Iron Co. operated its Isabella mine and 700-ton flotation plant at about double the 1933 rate, and as its smelter has been dismantled the copper concentrates were shipped to the Nichols Copper Co. for smelting. The Mascot mine and mill of the American Zinc Co. of Tennessee were operated in 1934 at a slightly higher rate than in 1933 but little development was accomplished other than some prospect drilling. The Universal Exploration Co. kept its 800-ton all-flotation plant running on zinc sulphide ore at a much higher percentage of capacity than in 1933; the blende concentrates shipped had an average zinc content of 64.69 percent. Universal also milled some zinc carbonate ore at its small plant. The Embree Iron Co., in Washington County, shipped high-grade zinc carbonate and galena concentrates direct to smelters. Fred Caldwell, of New Market, also shipped some zinc carbonate.

Virginia.—The quantity of gold produced by Virginia mines from 1828 to 1934, inclusive, is recorded as 160,291.97 fine ounces, of which only about 1,175 ounces were produced during the last 24 years. In 1934 Virginia yielded 667.10 ounces of gold and 103 ounces of silver; a few ounces of this gold and silver came from small placer operations in Floyd, Louisa, and Rockingham Counties.

There was a large increase in shipments of zinc and lead concentrates in 1934, but the Bureau of Mines is not at liberty to publish the figures for zinc or lead output as the Austinville mine of the Bertha Mineral Co. is the only producer of lead-zinc ore in Virginia.

Most of the gold output in 1934 was made by the Rapidan Gold Corporation of Fredericksburg, which operated the Melville mine near Wilderness in Orange County. A 250-foot shaft was sunk, about 2,400 feet of drifting were done, and a 50-ton all-flotation plant was built. The mine was worked throughout 1934, and the mill was operated from June to the end of the year. Some work was also done on the Vaucluse property adjoining the Melville. The flotation concentrates were shipped for smelting, and the gold recovered ranked the Rapidan Gold Corporation as the second largest producer in the Eastern States in 1934. The Franklin mine in Fauquier County and the Culpeper mine in Culpeper County were acquired by Paul G. Benedum, who sank the old shaft on the Franklin mine from a depth of 90 to 312 feet besides doing considerable underground and surface development. No plant was erected in 1934, and none will be built until a large quantity of ore is blocked out. The old United States mine in Spotsylvania County was purchased by North American Mines, Inc., and the shaft was reopened and repaired. Nothing was done at the Moss and Waller mines in the James River area.

MINE PRODUCTION IN THE CENTRAL STATES

Quantity and tenor of ores.—The only fair basis for comparing the relative magnitude of mining in different States is the quantity of crude ore or "dirt." The metal content of the ores of the several mining regions and States exhibits marked differences; therefore, comparison of tenor of the ores is interesting and significant. Virtually all the ore from the Central States is of such low tenor as to require concentration. In Kentucky and southern Illinois most of the lead and zinc concentrates are recovered as byproducts in the concentration of the fluorspar that they accompany, and the metal content of the crude ore raised cannot be calculated. In Arkansas very little ore has been mined for several years, and the average tenor calculated from the output of ore during these years would not offer accurate comparison with that during a period of active mining.

Quantity and tenor of copper, lead, and zinc ores, old tailings, etc., produced in the Central States, 1932–34, by States

State	1932		1933		1934	
	Ore, etc.	Metal content [1]	Ore, etc.	Metal content [1]	Ore, etc.	Metal content [1]
	Short tons	*Percent*	*Short tons*	*Percent*	*Short tons*	*Percent*
Kansas	750, 500	3. 92	1, 229, 000	3. 25	2, 096, 700	2. 67
Michigan	1, 142, 775	2. 38	697, 158	3. 36	700, 055	3. 44
Missouri	3, 786, 600	3. 19	2, 660, 800	3. 48	3, 415, 000	2. 94
Oklahoma	1, 587, 700	3. 70	3, 622, 100	3. 02	5, 927, 400	2. 35
Wisconsin	310, 300	3. 28	256, 400	3. 82	308, 600	3. 69
	7, 577, 875	----------	8, 465, 458	----------	12, 447, 755	----------

[1] The percentages represent the metal content of the ore insofar as it is recovered in the concentrates. In Michigan the metal so recovered is copper; in the other Central States the metals are lead and zinc combined, the relative proportions of which are shown in the table on p. 239 and in the tables of tenor of ore given in the sections devoted to the respective States.

Production of lead and zinc by regions.—The report of this series for 1930 (chapter of Mineral Resources of the United States, 1930, pt. I) gives the areas included in the seven lead- and zinc-producing regions of the Central States. Mineral Resources, 1914, contains brief reviews of the history of lead and zinc mining in the Central States, the yearly production of each State from 1907 to 1914, inclusive, and historical notes and estimates of the total production of lead and zinc in each State before 1907. Subsequent records year by year are found in Mineral Resources and Minerals Yearbook.

Mine production of lead and zinc in the Central States in 1934, by regions

Region	Lead [1]		Zinc [2]		Total value
	Short tons	Value	Short tons	Value	
Concentrates:					
Joplin or Tri-State	31, 897	$1, 240, 699	291, 036	$7, 897, 833	$9, 138, 532
Southeastern Missouri	121, 781	4, 505, 900	----------	----------	4, 505, 900
Upper Mississippi Valley [3]	340	12, 586	31, 489	365, 839	378, 425
Kentucky-southern Illinois	174	5, 427	[4] 394	5, 516	10, 943
Northern Arkansas	51	1, 900	182	2, 255	4, 155
	154, 243	5, 766, 512	323, 101	8, 271, 443	14, 037, 955
Total, 1933	150, 543	5, 590, 635	286, 156	7, 126, 499	12, 717, 134
Metal:					
Joplin or Tri-State	24, 465	1, 810, 410	153, 092	13, 165, 912	14, 976, 322
Southeastern Missouri	89, 580	6, 628, 920	----------	----------	6, 628, 920
Upper Mississippi Valley [3]	234	17, 316	9, 807	843, 402	860, 718
Kentucky-southern Illinois	144	10, 656	125	10, 750	21, 406
Northern Arkansas	40	2, 960	68	5, 848	8, 808
	114, 463	8, 470, 262	163, 092	14, 025, 912	22, 496, 174
Total, 1933	110, 073	8, 145, 402	145, 093	12, 187, 812	20, 333, 214

[1] Includes galena and a small quantity of lead carbonate concentrates.
[2] Includes sphalerite and a small quantity of zinc carbonate and zinc silicate concentrates.
[3] Includes Iowa, northern Illinois, and Wisconsin.
[4] Includes some lead-zinc ore.

REVIEW BY STATES

Arkansas.—In 1934, 182 tons of zinc carbonate concentrates were shipped from mines in Arkansas; the shippers were J. A. Goodall and Durst & Son, of Rush, and Ray Dardene, of Summit. About 51 tons of galena concentrates were shipped from the Brewer land at Ponca by the Urschel Mining Co. The total shipments of concentrates yielded 40 tons of lead and 68 tons of zinc.

Illinois.—None of the lead or zinc mines in northern Illinois were operated in 1934. Shipments from fluorspar mines in southern Illinois were only 58 tons of galena concentrates having an average lead content of 73.4 percent; the recoveries from these shipments were 40 tons of lead and 310 ounces of silver compared with 240 tons of lead and 1,422 ounces of silver recovered in 1933. The Hillside Fluor Spar Mines was the largest shipper in 1934.

Kansas.—The recovered lead in concentrates shipped from Kansas mines increased from 6,089 tons in 1933 to 6,805 tons in 1934; the recovered zinc in concentrates shipped decreased from 40,947 to 38,261 tons. The production of zinc concentrates increased in 1934, but one operator sold none of his output. The total quantity of crude ore and old tailings milled in Kansas in 1934 was 2,096,700 tons (1,229,000 tons in 1933), and the total shipments were 8,634 tons of galena concentrates, 100 tons of lead carbonate, and 72,862 tons of sphalerite concentrates. The galena concentrates had an average lead content of 79.7 percent and the sphalerite concentrates an average zinc content of 59.7 percent. The following average prices per ton were received by sellers of concentrates: Galena concentrates, $39.79; sphalerite concentrates, $27.59. The 1,163,300 tons of crude ore milled yielded, by weight, 0.90 percent in galena concentrates assaying 79.7 percent lead and 5.93 percent in sphalerite concentrates averaging 59.8 percent zinc. The 933,400 tons of old tailings treated yielded only 18 tons of galena concentrates but contained 1.38 percent in sphalerite concentrates averaging 58.9 percent zinc.

The total concentrates made by flotation in 1934 were 25,240 tons of sphalerite and 2,440 tons of galena.

Of the total shipments (72,862 tons) of sphalerite one mine in the Crestline district contributed 135 tons and one in the Waco district (Kansas side) 83 tons; the remainder came from mines near Baxter Springs and Blue Mound. The Baxter Springs and Blue Mound area also contributed 8,419 tons of galena concentrates. Mines at Galena shipped about 100 tons of galena and 100 tons of lead carbonate and those at Crestline 115 tons of galena.

Mine shipments of lead and zinc in Kansas, 1933–34

Year	Lead concentrates [1]		Zinc concentrates		Metal content [2]			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1933	7,832	$356,523	77,246	$2,077,251	6,089	$450,586	40,947	$3,439,548
1934	8,734	346,557	72,862	2,010,505	6,805	503,570	38,261	3,290,446

[1] Includes 80 tons of lead carbonate, containing 47 percent lead, from Galena in 1933 and 100 tons of lead carbonate, containing 63 percent lead, in 1934.

[2] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and old tailings milled and concentrates produced in Kansas, 1933–34

	1933		1934	
	Crude ore	Old tailings	Crude ore	Old tailings
Total ore and old tailings milled____short tons__	725,400	503,600	1,163,300	933,400
Total concentrates shipped:				
Galena____do____	[1] 7,734	18	[2] 8,631	3
Sphalerite____do____	69,412	7,834	60,026	12,836
Ratio of concentrates to ore, etc.:				
Lead____percent__	0.83	________	0.90	________
Zinc____do____	6.67	1.56	5.93	1.38
Metal content of ore, etc.:				
Lead____do____	.66	________	.72	________
Zinc____do____	4.03	.91	3.54	.81
Average lead content of galena concentrates____do____	79.6	77.7	79.7	66.6
Average zinc content of sphalerite concentrates__do____	60.4	58.3	59.8	58.9
Average value per ton:				
Galena concentrates____	$45.69	$41.72	$39.79	$38.66
Sphalerite concentrates____	26.66	28.93	27.78	26.73

[1] Also 80 tons of lead carbonate.
[2] Also 100 tons of lead carbonate.

The output from Crestline was made by the Pershing Mining Co. and that from Waco by the Eden Mining Co. from the old Acme mine. The new Bailey tailing mill at Waco was completed in December 1934 but was not operated until 1935.

Mines near Baxter Springs shipped 635 tons of galena and 13,724 tons of sphalerite concentrates in 1934. Very little drilling was done in this section, but some small mines such as the Blue Circle were opened. Several old properties were reopened and operated, including the Robob, Hunter, and Beck. The principal shippers in 1934 were the Lucky O. K. Mining Co., Baxter Chat Co. (Hartley tailings), Beck Mining Co., Barnsdall Zinc Co., Iron Mountain Lead & Zinc Co., Peru Mining Co., Robob Mining Co. (ore milled at the Central mill in Okahoma), and St. Louis Smelting & Refining Co. (No. 8 mine); the sphalerite concentrates milled at the No. 8 mine were shipped, but all the galena recovered was held in bins at the mine.

Mines in the Blue Mound area, which in 1933 shipped 6,520 tons of galena and 67,520 tons of sphalerite concentrates, made little change in output in 1934. Shipments of galena in 1934 amounted to 7,784 tons and those of sphalerite to 58,920 tons, and several of the mines in this section hold considerable quantities of concentrates in bins; the larger shippers were the Jay Hawk Mining Co. (tailings), Black Eagle Mining Co. (tailings and ore), Eagle-Picher Mining & Smelting Co. (Bendelari mine), Mid Continent Lead & Zinc Corporation, Vinegar Hill Zinc Co. (Barr mine), Redskin Mining Co., Cortez King Brand Mining Co. (tailings), and Commerce Mining & Royalty Co. (Webber and Chubb tailings). The Federal Mining & Smelting Co. operated its Jarrett mine steadily but not at capacity, and no lead or zinc concentrates were shipped; at the end of 1934 this operator held about 65 percent of all the sphalerite stocks in the Tri-State region. A new mill (capacity, 250 tons in 10 hours) was erected by the New Blue Mound Mining Co., but it was not operated until the last week of the year. The Baxter Chat Co. plant was moved from the Lucky

O. K. mine to the Hartley mine. The Bendelari mill of the Eagle-Picher Mining & Smelting Co. was operated about 60 days; after that the crude ore was sent to the Central mill in Oklahoma for treatment.

Kentucky.—In 1934 mines in Kentucky shipped 88 tons of zinc carbonate concentrates, 306 tons of lead-zinc ore, and 116 tons of galena concentrates yielding in all 104 tons of lead and 125 tons of zinc; the shippers were Avery H. Reed, Roberts & Frazer, the Lafayette Fluorspar Co., and the lessees of the Sheridan Zinc Co. The zinc was shipped to the Grasselli Chemical Co. and the Ozark Smelting & Mining Co.

Michigan.—In 1934 the Ishpeming Gold Mining Co. cyanided some old tailings from the Ropes mine at Ishpeming and recovered gold, but it was not refined or marketed. The Calumet & Hecla Consolidated Copper Co. has purchased the controlling interest in the Ropes property and is actively developing it. The mine has 15 levels to 850 feet and probably will be unwatered by April 1, 1935. The new owners also have optioned 400 acres west of the Ropes which will be prospected. The Michigan Gold Mines, Inc., of Ishpeming sank a 75-foot shaft and mined some ore in 1934 which was treated by amalgamation at an experimental plant; the mine was worked intermittently during 1934, and its owners have not decided what process will be used in milling.

In 1934, as in 1933, two companies—Calumet & Hecla Consolidated Copper Co. and Copper Range Co.—contributed the total output of copper in Michigan. Production in 1934 amounted to 700,055 tons of rock, which yielded 70,102,754 pounds of mineral containing 48,215,859 pounds of recovered or recoverable copper; the output in 1933 amounted to 697,158 tons of rock, 68,999,174 pounds of mineral, and 46,853,130 pounds of copper. The treatment of rock containing a relatively high percentage of copper was continued in 1934, and the yield of copper from the rock treated was 3.44 percent compared with 3.36 percent in 1933. The average yield in 1934 was more than three times that in 1927.

The mine inspector of Houghton County reported[3] that on October 1 in the Michigan copper district 2,093 men were employed—939 underground and 1,154 in the mills and on the surface. Calumet & Hecla had 404 men underground and 820 on the surface; Copper Range had 523 men underground and 277 on the surface; Isle Royale, closed, had 4 men on the surface; and Quincy Mining, although not operating, was maintaining its pumps and had 12 men underground and 53 on the surface. The total of 939 men employed underground in the district in 1934 compares with 811 in 1933 and 3,690 in 1930.

[3] Quoted in Engineering & Mining Journal, November 1934, p. 531.

Mine production of gold, silver, and copper in Michigan, 1929–34 [1]

Year	Gold (fine ounces)	Silver (fine ounces)	Copper			Concentrate ("mineral")		Ore ("rock") (short tons)
			Pounds	Yield: Pounds per ton of ore ("rock")	Yield: Percent	Pounds	Yield (percent copper)	
1929		20,795	[2] 186,402,218	[2] 24.5	[2] 1.23	[3] 286,583,602	[3] 65.0	[4] 7,598,180
1930		7,820	[2] 169,381,413	[2] 25.4	[2] 1.27	[3] 258,005,986	[3] 65.7	[4] 6,659,036
1931		1,437	118,059,491	33.1	1.65	172,431,815	68.5	3,570,748
1932		71,408	54,396,108	47.6	2.38	79,753,030	68.2	1,142,775
1933	9.67	[5] 125,926	46,853,130	67.2	3.36	68,999,174	67.9	[6] 697,158
1934	58.63	[5] 529	48,215,859	68.9	3.44	70,102,754	68.8	[7] 700,055

[1] Figures based on actual recovery of copper from "mineral" smelted and estimated recovery from "mineral" not smelted during year.
[2] Includes copper from sands.
[3] Includes "mineral" from sands.
[4] Includes sands.
[5] According to Bureau of the Mint.
[6] Excludes 200 tons of old tailings cyanided for recovery of gold and silver.
[7] Excludes 800 tons of ore amalgamated for recovery of gold and silver.

Value of silver and copper produced in Michigan mines, 1929–34

Year	Silver	Copper: Total	Copper: Per ton of ore ("rock")	Total	Year	Silver	Copper: Total	Copper: Per ton of ore ("rock")	Total
1929	$11,084	$32,806,790	$4.32	$32,817,874	1932	$20,137	$3,426,955	$3.00	$3,447,092
1930	3,011	22,019,584	3.31	22,022,595	1933	[1] 44,074	2,998,600	4.30	3,042,674
1931	417	10,743,414	3.01	10,743,831	1934	[1] 342	3,857,269	5.51	3,857,611

[1] According to Bureau of the Mint.

Mining operations of the Calumet & Hecla Consolidated Copper Co. were continued on a restricted scale in 1934 and again were confined to the old backs and shaft pillars in the upper part of the conglomerate lode. Production in 1934 amounted to 32,846,594 pounds of copper at an average cost sold (not including depreciation and depletion) of 7.08 cents a pound and 1,789,608 pounds of oxide at an average cost sold of 4.77 cents; the output in 1933 was 33,197,106 pounds of copper at an average cost of 6.75 cents and 1,928,893 pounds of oxide at an average cost of 5.23 cents. The average selling price per pound in 1934 was 8.56 cents for copper and 6.68 cents for oxide compared with 6.82 and 6.09 cents, respectively, in 1933. Rock from the conglomerate lode totaling 458,880 tons was stamped at the Calumet mill at Lake Linden in 1934. The smelter treated 27,198 tons of concentrates from current production and stocks and produced 37,364,501 pounds of refined copper. It was found necessary to operate two pumps in the conglomerate lode in 1934 to take care of water originating in the upper levels of the mine, after all pumping had been stopped in 1933.

The Champion mine of the Copper Range Co. produced at a monthly rate of 1,150,000 pounds, 15 percent higher than in 1933. The average cost of production in 1934 was 8.69 cents a pound, and the average sales price was 8.55 cents a pound. The rate of sales was 12 percent below that of production. The stamp mill treated 241,175 tons of rock yielding 13,929,859 pounds of copper. The average recovery of 57.76 pounds to the ton of rock treated was only a little lower than the high recovery of 59.66 pounds attained in 1933.

Copper produced by the Champion mine of the Copper Range Co., 1929–34

Year	Rock stamped	Copper produced	Yield per ton	Cost per pound [1]	Price received
	Short tons	*Pounds*	*Pounds*	*Cents*	*Cents*
1929	446,804	20,660,701	46.24	11.76	17.94
1930	(2)	19,999,564	44.57	11.60	11.43
1931	[3] 404,830	[3] 17,721,270	[3] 43.77	[3] 9.754	[3] 8.2
1932	291,265	12,188,578	41.847	8.646	6.0
1933	203,940	12,167,130	59.66	7.51	7.46
1934	241,175	13,929,859	57.76	8.69	8.55

[1] Excludes depreciation and depletion.
[2] Figures not given.
[3] Includes Baltic mine.

Missouri.—The following tables show the production of lead and zinc in southwestern Missouri and the tenor of ore ("dirt") and concentrates from Missouri.

As only one large tailing mill was operated in Missouri in 1934 the Bureau of Mines is not at liberty to give detailed separate recoveries from old tailings. The 155,600 tons of crude ore milled in southwestern Missouri yielded 0.82 percent in lead concentrates and 6.35 percent in zinc concentrates.

Mine production of lead and zinc in southwestern Missouri, 1933–34

Year	Lead concentrates				Zinc concentrates				Metal content [1]			
	Galena		Carbonate		Sphalerite		Silicate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1933	1,170	$44,337	307	$9,750	8,798	$245,064	1,325	$19,887	1,010	$74,740	5,042	$423,528
1934	846	30,790	428	11,829	12,691	345,925	1,200	17,437	913	67,562	7,059	607,074

[1] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and old tailings treated and concentrates produced in southwestern Missouri, 1931–34

	1931	1932	1933	1934
Total ore and old tailings treated ....short tons..	104,800	46,400	170,800	425,500
Total concentrates in ore:				
Lead ....percent..	1.63	3.61	0.81	0.30
Zinc ....do....	3.76	4.69	4.51	3.26
Metal content of ore:				
Lead ....do....	1.15	2.48	.60	.22
Zinc ....do....	2.15	2.60	2.51	1.88
Average lead content of galena concentrates ....do....	74.6	75.6	72.3	78.0
Average lead content of lead carbonate concentrates ....do....	59.1	59.6	60.6	63.4
Average zinc content of sphalerite concentrates ....do....	58.6	59.5	59.8	59.5
Average zinc content of silicates and carbonates ....do....	39.0	39.8	39.4	39.3
Average value per ton:				
Galena concentrates	$41.21	$30.43	$37.89	$36.40
Lead carbonate concentrates	31.78	22.43	31.76	27.64
Sphalerite concentrates	22.05	16.37	27.85	27.26
Zinc silicates and carbonates	12.63	10.51	15.01	14.53

Tenor of lead ore and concentrates in southeastern Missouri disseminated-lead district, 1931–34

	1931	1932	1933	1934
Total lead ore ... short tons	5,135,600	3,740,200	2,490,000	2,989,500
Galena concentrates in ore ... percent	4.36	4.36	4.67	4.07
Zinc content of ore ... do	.04	.01	----------	----------
Average lead content of galena concentrates ... do	72.4	72.7	73.7	75.06
Average value per ton of galena concentrates	$43.93	$30.01	$35.12	$37.00
Average zinc content of sphalerite concentrates ... percent	57.6	57.15	----------	----------
Average value per ton of sphalerite concentrates	$17.86	$16.25	----------	----------

Mine shipments of lead and zinc concentrates in southeastern and central Missouri, 1907–34

Year	Lead concentrates (galena)		Zinc concentrates			
			Sphalerite		Carbonate and silicate	
	Short tons	Value	Short tons	Value	Short tons	Value
1907–30	6,131,266	$398,600,172	33,746	$1,106,755	10,285	$233,534
1931	223,853	9,833,045	2,408	43,000	----------	----------
1932	162,989	4,891,978	80	1,300	----------	----------
1933	116,226	4,081,486	----------	----------	----------	----------
1934	121,781	4,505,900	----------	----------	----------	----------

The value of the silver, copper, lead, and zinc shipped from Missouri mines was $7,348,028 in 1934 compared with $6,712,048 in lead and zinc in 1933. No silver was recovered from lead or copper ores in 1933 or 1934, but silver skimmings from lead refining yielded 63,066 ounces of silver in 1934; in addition, lead ores yielded 46,276 pounds of copper. The quantity of recovered lead increased from 84,980 tons in 1933 to 90,493 tons in 1934, and the recovered zinc increased from 5,042 to 7,059 tons.

Shipments of lead concentrates (of which only 428 tons were lead carbonate) were 123,055 tons in 1934 compared with 117,703 tons in 1933. Of the total in 1934, 121,781 tons were shipped from mines in southeastern Missouri and averaged 75.06 percent lead; the recovered lead content was 89,580 tons in 1934 compared with 83,970 tons in 1933.

No zinc concentrates were recovered in or shipped from southeastern Missouri in 1934.

Shipments of lead concentrates from mines in southwestern Missouri comprised 846 tons of galena and 428 tons of lead carbonate. In 1934 as in 1933 the quoted price for galena concentrates was that paid for medium-size lots, and sellers of larger than carload lots were paid $1 to $3 above the quoted prices.

The total value of concentrates sold is based on actual receipts by the sellers and not on quoted prices.

The average weekly quoted price for galena concentrates at Joplin was $42.50 a ton for the first 13 weeks of 1934, rose rapidly in the next 2 weeks to $47.50 for the week of April 14, and remained at that level for 6 weeks; in the week of May 26 the price fell again to $42.50 and continued to decline until it reached $32 a ton in the last week of

November, the low point for the year. The price recovered somewhat in the second week of December and was $36 a ton at the end of the year.

The price of zinc blende concentrates at Joplin was $25 a ton at the beginning of 1934, rose to $30 a ton (the highest quotation of the year) in the week ended February 10, and continued at that level with minor fluctuations through the week ended May 5; from the third week in May through the last week in August the price fluctuated between $26 and $28, declined to $25 in the week ended September 8, and continued downward to $23 (the lowest quotation of the year) in the last week in September. The price recovered somewhat during the last quarter and was $26 a ton as the year closed.

All the zinc concentrates shipped from Missouri mines in 1934 were from properties in southwestern Missouri. The total quantity of blende concentrates shipped was 12,691 tons, an increase of 3,893 tons over 1933; they had an average zinc content of 59.5 percent and brought an average price of $27.26 a ton.

Shipments of zinc silicate in 1934 were 1,200 tons (125 tons less than in 1933) and averaged 39.3 percent zinc. All the silicate was purchased at a flat price, as there were no quoted prices, and demand was limited to two purchasers.

Flotation concentrates made in Missouri in 1934 totaled 4,061 tons of sphalerite and 48,937 tons of galena.

The quantity of crude ore and old tailings treated in 1934 was 3,415,000 tons. The amount received for all classes of lead and zinc concentrates sold in 1934 averaged $1.44 a ton of crude ore and old tailings treated (21 cents less than in 1933). This decrease was due mainly to the larger quantity of old tailings treated in 1934.

There was no special demand in 1934 for lead-free sphalerite concentrates, and such concentrates brought no premium. During most of the year flotation blende concentrates were quoted at $1 a ton less than jig and table concentrates. Some zinc concentrates were shipped under contract and not sold to smelters; these concentrates were valued at the current weekly base price of sphalerite on the date of shipment.

About 25 mines and 14 mills were active in southwestern Missouri in 1934; only a few operated steadily, and more than half the zinc was produced by two operators.

The largest shippers of blende concentrates were the Missouri Mining Co., which operated a 600-ton tailing plant at Chitwood, and the American Zinc, Lead & Smelting Co., which operated a 250-ton plant at Diamond. Other large shippers of zinc concentrates were the Locklyn Lead & Zinc Co. at Stotts City; the Playter Mining Co. and other operators who used the Playter mill at Waco; the 66 Mine Corporation at Carthage; the Zig Zag Mining Co. at Joplin; the Connico Mining Co. at Fidelity; and the Mineral Recoveries Co. at Webb City, which treated old slimes. The zinc silicate shipped in 1934 was mainly from small mines at Granby, Joplin, and Westplains, with small quantities from Aurora, Wentworth, Diamond, and Diggins. The lead concentrates shipped were mainly small lots produced near Joplin, Oronogo, Granby, Waco, and Stotts City.

Some surface work was done by labor paid for by State relief funds preparatory to unwatering the mining area near Oronogo and Webb City. The unwatering is being done by private interests, as the

P. W. A. refused a loan to unwater the old mines and to build a large central milling plant. Some drilling is being done in this area, but no mill is contemplated pending examination and development of the old and new properties.

The lead ore (2,989,500 tons) mined in the disseminated-lead district of southeastern Missouri yielded 4.07 percent in galena concentrates averaging 75.06 percent lead. As mine operators mine and smelt their lead concentrates, the assigned value of $37 a ton is more or less arbitrary. The low price of lead had the effect of eliminating small producers, and the St. Louis Smelting & Refining Co., subsidiary of the National Lead Co., did not operate any mines in 1934. The mines and mills of the St. Joseph Lead Co., which have a daily capacity of about 17,000 tons, were operated at the following percentages of capacity in 1934: January and February, 50 percent; March to the end of October, 41.67 percent; and November and December, 50 percent.

Oklahoma.—About 60 mills (large and small) were active in Oklahoma in 1934, but only 1 or 2 of them were in successive daily operation. About 2,800 tons of the galena concentrates produced and 71,000 tons of the sphalerite were flotation products. Stocks of concentrates were kept down to 2 weeks' supply, and most of the stocks of zinc concentrates were held by a few operators who had no intention of selling them except at a much higher price than prevailed in 1934. Very little exploration drilling was done, and no new territory was opened. None is needed at present, as the mills running were hampered by the necessity of closing down part of nearly every month to prevent accumulation of stocks in mill bins. This procedure increased mining and milling costs, and it is doubtful if any operators but a few working very rich crude made money in 1934. Prices for both blende and galena concentrates, which trended upward early in 1934, slumped badly in the middle and at the end of the year. Few new mills were built, but many were moved to new locations or remodeled to treat mill tailings instead of crude ore.

Nearly 830,000 tons more old tailings than crude ore were treated, and the output of sphalerite concentrates in Oklahoma in 1934 was over 50,000 tons from the tailing mills and about 153,000 tons from crude ore. The tailing mills produce very little lead, even when equipped with flotation units, and the galena concentrates usually are of low grade.

Mine shipments of lead and zinc in Oklahoma in 1934, by districts

District	Lead concentrates (galena)		Zinc concentrates (sphalerite)[2]		Metal content[1]			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Miami	21,804	$848,123	204,223	$5,523,186	16,680	$1,234,320	107,753	$9,266,758
Peoria	85	3,400	[2] 60	780	67	4,958	19	1,634
	21,889	851,523	204,283	5,523,966	16,747	1,239,278	107,772	9,268,392
Total, 1933	23,638	1,046,575	172,211	4,443,854	18,038	1,334,812	91,065	7,649,460

[1] In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

[2] Output from Peoria in 1934 is zinc silicate containing 38 percent zinc.

Tenor of lead and zinc ore, old tailings, and slimes milled and concentrates produced in Oklahoma, 1933–34

	1933		1934	
	Crude ore	Old tailings and slimes	Crude ore	Old tailings and slimes
Total ore, etc., milled short tons	2,188,200	1,433,900	2,549,500	3,377,900
Total concentrates shipped:				
Galena do	23,193	445	21,441	448
Sphalerite do	[1] 148,541	23,554	[2] 153,752	50,471
Ratio of concentrates to ore, etc.:				
Lead percent	0.92	0.03	0.95	----------
Zinc do	6.02	1.53	6.00	1.50
Metal content of ore, etc.:				
Lead do	.72	.02	.74	----------
Zinc do	3.63	.97	3.62	.88
Average lead content of galena concentrates do	78.1	63.8	78.4	62.7
Average zinc content of sphalerite concentrates do	60.3	58.9	60.3	58.8
Average value per ton:				
Galena concentrates	$44.60	$27.39	$39.16	$26.59
Sphalerite concentrates	25.64	26.85	28.14	26.20

[1] Also 116 tons of zinc silicate.
[2] Also 60 tons of zinc silicate.

Mine production of lead and zinc concentrates in Oklahoma, 1891–1934, by districts

District	Lead concentrates (mainly galena)		Zinc concentrates			
			Sphalerite		Zinc silicate and carbonate	
	Short tons	Value	Short tons	Value	Short tons	Value
Davis	----------	----------	558	$27,399	899	$24,592
Miami [1]	1,107,904	$94,529,132	6,126,289	245,860,793	164	2,692
Peoria	2,639	127,163	220	8,289	3,120	79,649
	1,110,543	94,656,295	6,127,067	245,896,481	4,183	106,933

[1] Including Quapaw and Sunnyside.

At the old camp of Peoria the Log Cabin Mining Co. shipped some galena and zinc silicate in 1934 from the McConkey land before suspending operations. A number of leases were worked at Commerce, and 410 tons of galena and 1,246 tons of sphalerite were shipped, mainly from the Midas and Lost Trail leases. The Quapaw-Sunnyside area had numerous small operators, some of whom milled their ore at custom mills such as the Mission, Mary Jane, and others. Among the shippers of concentrates in 1934 were the Atlas Milling Co. (tailings), Mission Mining Co., White-McKay Mining Co., Prairie Chicken Mining Co., F. W. Evans (John L mill), Kansas & Oklahoma Mining Trust (Discard mine), Diamond Joe Mining Co., and the Mary Jane Mining Co.

The shipments of galena and sphalerite from the Douthat area were mainly those of the Admiralty Zinc Co., Ramage Mining Co., Skelton Lead & Zinc Co., and Lawyers Lead & Zinc Co. The Ramage was one of the few mills operating steadily in 1934; its lease expired early in 1935.

Mines in the Hockerville-St. Louis area shipped 2,454 tons of galena and 26,853 tons of sphalerite concentrates in 1934. The larger shippers were the Mary M. Mining Co., St. Louis Smelting & Refining Co., Canadian Mining & Milling Co., Sullivan & Williams Mining Co. (Farmington mine), Lucky Ox Mining Co., Massell Mining Co., Blue Bonnet Mining Co., and C. Y. Semple (Brewster tailings).

Near Picher and Cardin the larger shippers in 1934 were the Eagle-Picher Mining & Smelting Co., Davis Mining Co., Tri-State Zinc Co. (tailings), Cardin Milling Co. (tailings), Peru-Laclede Syndicate (tailings), Interstate Zinc & Lead Co., W. H. Aul & Co. (tailings), Evans Wallower Lead Co., Commerce Mining & Royalty Co. (3 mills), Rialto Mining Corporation, Velie Mines Corporation, Century Zinc Co. (Barnsdall mine), Pioneer Lead & Zinc Co. (tailings), F. & B. Milling Co. (tailings), Britt Milling Co. (tailings), Youngman Milling Co. (tailings), Meyers Milling Co. (tailings), A. J. Hutts Milling Co. (tailings), Dines Mining Co. (Wilson mine), and United Zinc Smelting Corporation.

Among the mines operated by sublessees and outside leases and shipping crude ore to the large Central mill (6,000 tons daily capacity) of the Eagle-Picher Mining & Smelting Co. were the Blue Diamond, Davis 1 and 2, Crystal, Waxahachie, Kitty, St. Joe, Golden Hawk, Mudd, Foch, Tri-State, Robob, and Underwriters 1, 2, and 4.

Wisconsin.—The increase in shipments of zinc concentrates from Wisconsin mines in 1934 was due solely to the operations of the Vinegar Hill Zinc Co., the only large producer in the State during the year. Few of the mines and mills of the State were in operation, and little development was done. Nearly all the raw zinc concentrates were shipped to the National roasting plant of the Vinegar Hill Zinc Co. at Cuba City. The company worked the Crawford and Trewartha mines steadily in 1934; it also acquired (by subleasing) the Blockhouse mine near Platteville, which had been idle several years, and operated it in November and December. The Crawford mine ore body was extended on the Thomas land, and an electric shovel was installed underground. The Badger Zinc Co. all-flotation plant was idle throughout 1934, and only small lots of raw concentrates were mined in the Benton, Linden, and Shullsburg districts; the largest of the small shippers was the Murray Mining Co. of Shullsburg.

Mine production of lead and zinc in Wisconsin, 1933–34

Year	Lead concentrates		Zinc concentrates (sphalerite)		Metal content [1]			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1933	760	$31,056	25,786	$331,242	540	$39,960	7,800	$655,200
1934	340	12,586	31,489	365,839	234	17,316	9,807	843,402

[1] In calculating the metal content of the ores from assays allowance has been made for roasting and smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1931–34

	1931	1932	1933	1934
Total ore........short tons..	318,700	310,300	256,400	308,600
Total concentrates in ore:				
Lead........percent..	0.41	0.42	0.30	0.11
Zinc........do....	10.7	9.07	10.01	10.20
Metal content of ore:				
Lead........do....	.30	.30	.22	.08
Zinc........do....	3.69	2.98	3.60	3.61
Average lead content of galena concentrates........do....	74.3	70.7	72.5	70.3
Average zinc content of sphalerite concentrates........do....	34.3	32.9	35.7	35.4
Average value per ton:				
Galena concentrates........	$45.35	$29.34	$40.86	$37.02
Sphalerite concentrates........	9.28	6.34	12.85	11.62

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA [1]

(MINE REPORT)

By F. W. HORTON AND H. M. GAYLORD

SUMMARY OUTLINE

In 1934 Nevada mines produced, in terms of recovered metals, 143,800 fine ounces of gold, 2,850,000 fine ounces of silver, 41,750,000 pounds of copper, 21,500,000 pounds of lead, and 27,500,000 pounds of zinc, according to preliminary figures. This output compares with a production in 1933 of 98,590.28 ounces of gold, 1,148,621 ounces of silver, 28,489,610 pounds of copper, 4,606,732 pounds of lead, and 12,774,550 pounds of zinc. The increases in quantity in 1934 were as follows: Gold 46 percent, silver 148 percent, copper 47 percent, lead 367 percent, and zinc 115 percent.

The total value of the output of the five metals in 1934 was $12,186,234 compared with $5,452,300 in 1933, an increase of 124 percent and the largest total value since 1930. Increases in average price per ounce from $25.56 to $34.95 for gold and from $0.35 to $0.646+ for silver greatly stimulated the production of these metals. Gold was the leading metal in terms of marketed value in 1934. The proportion of the State total value supplied by each of the five metals was as follows: Gold 41 percent, copper 27 percent, silver 15 percent, zinc 10 percent, and lead 7 percent.

There was a general increase in mining activity throughout the State, but leasing was more in vogue than mining on company account, particularly in the Divide, Manhattan, and Tonopah districts. A notable revival of mining occurred along the Comstock Lode, where some of the well-known early day bonanza mines were rehabilitated, a number of new mills were erected, and several existing mills were enlarged. There were heavy shipments of ore from the Pioche district. The Battle Mountain, Jack Rabbit, Round Mountain, Silver Peak, and Tybo districts and the Lane City area in the Ely (Robinson) district were other important producing localities in 1934.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

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Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly U.S. Government prices.[2] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, copper, lead, and zinc in Nevada, 1930–34, in terms of recovered metals

Year	Gold	Silver	Copper	Lead	Zinc	Total value
	Fine ounces	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1930	149,064.47	4,219,832	109,203,512	23,058,381	29,168,117	$21,455,517
1931	142,293.76	2,562,071	72,634,497	15,860,634	20,861,348	11,673,787
1932	129,719.83	1,304,365	31,487,606	880,986	254,795	5,067,171
1933	98,590.28	1,148,621	28,489,610	4,606,732	12,774,550	[1] 5,452,300
1934 [2]	143,800.00	2,850,000	41,750,000	21,500,000	27,500,000	12,186,234

[1] Change in value from chapter on Nevada in the Statistical Appendix to Minerals Yearbook, 1934, due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).
[2] Subject to revision.

Gold.—According to preliminary figures, the output of gold in Nevada in 1934 was 143,800 fine ounces valued at $5,025,810, a gain of 45,210 ounces (46 percent) and $2,505,842 (99 percent) over 1933. The quantity of gold produced was the greatest since 1930 and the value the largest since 1918. The Nevada Consolidated Copper Corporation was the largest gold producer in the State in 1934; its mines at Ruth in the Ely (Robinson) district, White Pine County, and its smelter at McGill were operated intermittently throughout the year. Although most of the gold from the Ely (Robinson) district was derived as a byproduct in the treatment of porphyry copper ores, the production of gold from siliceous ores used as flux at the McGill smelter was also important; such siliceous ores were mined principally in the Lane City area. Other leading gold producers were the White Caps Gold Mining Co., Manhattan district; Nevada

[2] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U.S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

Porphyry Gold Mines, Inc., Round Mountain district; the Mary mine, Silver Peak district; Bradshaw Syndicate, Inc. (Goldfield Consolidated Mines Co. tailings dump), Goldfield district; Dayton Consolidated Mining Co., Silver City district; and Tonopah Mining Co. (leasers), Tonopah district. The rest of the gold output was derived from small operations yielding less than 5,000 ounces.

On the Comstock Lode the Arizona Comstock Corporation increased the capacity of its 110-ton flotation mill at Virginia City to 330 tons, and the Dayton Consolidated Mining Co. completed the erection of a 120-ton all-slime cyanide plant 4 miles north of Mound House. The Consolidated Chollar Gould & Savage Mining Co. increased the daily capacity of its flotation mill at Gold Hill from 50 to 150 tons. Other mills along the Comstock Lode include the Overland 50-ton flotation mill 1½ miles southeast of Gold Hill, the Hartford 50-ton cyanide mill at Silver City which was completed in the latter part of the year, the Bradley flotation plant for the treatment of the Lynch tailings dump at Virginia City, and the Donovan amalgamation and cyanidation plant and Trimble amalgamation mill, both at Silver City.

In the Silver Peak district, Esmeralda County, the Mary mine was the leading gold producer in the county. Ore from this mine was treated largely in the Black Mammoth 50-ton amalgamation-flotation mill at Silver Peak 11 miles from the mine, but some higher-grade ores were shipped crude to the Garfield (Utah) smelter, via Blair Junction.

In the Goldfield district Bradshaw Syndicate, Inc., installed new equipment at the old cyanide plant of Bradshaw, Inc., to treat a large tonnage of tailings of the Goldfield Consolidated Mines Co., previously considered worthless. At the old camp of Hornsilver (now Gold Point), 30 miles south of Goldfield, the Ohio Mines Corporation rehabilitated its mine and installed a 100-ton cyanidation plant; the mill was expected to be in operation early in 1935. The Caliente Cyaniding Co., in the Ferguson district, Lincoln County, was erecting a 150-ton cyanide plant to treat old tailings on the Golden Eagle and Monatare claims 30 miles southwest of Caliente. The Gold Circle Consolidated Mines treated gold ore from the Elko Prince mine in its 75-ton cyanide plant and shipped the precipitates to the Selby (Calif.) smelter. The Dixie Comstock gold property in Churchill County was equipped with a 35-ton mill, and some bullion was shipped.

A number of placers in the State were worked during the year by small-scale operators who used dry methods where water was not available, but the chief placer-gold output was from the Round Mountain district, Nye County.

Silver.—According to preliminary figures, the output of silver from mines in Nevada in 1934 was 2,850,000 fine ounces valued at $1,842,424, a gain of 1,701,379 ounces (148 percent) and $1,440,407 (358 percent) over 1933. The quantity of silver produced was the greatest since 1930 and the value the largest since 1929. The reopening of the Tybo mines of the Treadwell Yukon Co., Ltd., in Nye County, closed throughout 1933, made Tybo one of the largest silver-producing districts in the State in 1934; the company was the largest individual producer of silver. The Pioche mines of the Combined Metals Reduction Co. were the next largest source of silver, followed by the Tonopah Mining Co. property operated by leasers, the Bristol Silver Mines Co., the Arizona Comstock Corporation, the Consolidated Chollar Gould & Savage Mining Co., and the Tonopah Extension Mines, Inc., each producing over 100,000 ounces of silver. The Ely (Robinson) district contributed considerable silver as a byproduct from the treatment of porphyry copper ores, also notable quantities from siliceous ores mined in the Lane City area and used as flux at the McGill smelter. During the year the General Metals Recovery Corporation entirely reconstructed its cyanide plant to treat the tailings of the Tonopah Mining Co. at Millers and resumed operations October 1. Precipitates were shipped to the Selby smelter. The values in the tailings were mostly silver with subordinate amounts of gold.

Copper.—The production of copper from Nevada mines in 1934 was 41,750,000 pounds valued at $3,340,000, an increase of 13,260,390 pounds (47 percent) and $1,516,665 (83 percent) over 1933. The increase of 25 percent ($0.016 per pound) in average price of copper over the 1933 average was of material assistance to copper producers, and the output was the largest in both quantity and value since 1931. The Nevada Consolidated Copper Corporation was the largest copper producer in the State, resuming intermittent operation of its porphyry copper properties at Ruth, in the Ely (Robinson) district, White Pine County, and at its smelter at McGill. The Ely (Robinson) district continued as the chief copper-producing section of the State. Large quantities of copper were recovered from lead concentrates shipped from the Tybo district, Nye County, and from lead ore shipped from the Bristol Silver property in the Jack Rabbit district, Lincoln County. The rest of the copper output was largely a byproduct from gold and silver ores, mostly from the Battle Mountain and Bullion districts, Lander County.

Lead.—The lead output from Nevada ores in 1934 was 21,500,000 pounds valued at $795,500, an increase of 16,893,268 pounds and $625,051 over 1933. The production was the largest in quantity and value since 1930. As the average price of lead in 1934 ($0.037 per pound) was the same as in 1933 the relative increases in quantity and value were identical—367 percent. This large increase was due to resumption of mining by the Treadwell Yukon Co., Ltd., in the spring and shipment of lead concentrates from its Tybo mine and 350-ton flotation mill in Nye County. The Combined Metals Reduction Co. in the Pioche district, Lincoln County, shipped ore to its flotation mill at Bauer, Utah, and was the largest producer of lead in Nevada. The Treadwell Yukon Co., Ltd., Tybo district, the Bristol Silver Mines Co., Jack Rabbit district, and the Prince Consolidated Mining Co., Pioche district, were the next largest shippers. Leasers at the Richmond Eureka mine in the Eureka district shipped lead-silver ore during midyear.

Zinc.—The output of zinc from Nevada mines in 1934 was 27,500,000 pounds valued at $1,182,500, a gain of 14,725,450 pounds (115 percent) and $645,969 (120 percent) over 1933. This was the State's largest and most valuable output of zinc since 1930. Virtually all the zinc marketed came from lead-zinc ores mined by the Combined Metals Reduction Co. at Pioche and the Treadwell Yukon Co., Ltd., at Tybo. The Combined Metals Reduction Co., by far the largest producer, concentrated its ore at its flotation plant at Bauer, Utah, and shipped the zinc concentrate to the electrolytic zinc plant of the Anaconda Copper Mining Co. in Montana. The Treadwell Yukon Co., Ltd., shipped the zinc concentrates from its 350-ton flotation mill to the Amarillo (Tex.) plant of the American Smelting & Refining Co. A small production of zinc was made from ore mined by leasers at the Boston Ely and Smokey Group claims of the Consolidated Coppermines Corporation at Kimberly in the Robinson district.

REVIEW BY COUNTIES AND DISTRICTS

Churchill County.—There was a small production of gold, silver, and lead in Churchill County in 1934. Shipments of high-grade gold ore aggregating about 115 tons were made to the Garfield (Utah) smelter by lessees of the Gold Cross mine in the Gold Butte district after unsuccessful attempts to extract the gold economically by milling. The Comstock-Keystone Mining Co. treated 1,422 tons of ore from the Dixie Comstock mine in the Wonder district in its 35-ton mill by amalgamation, impounding the tailings for future cyanidation, and shipped 231 tons of ore to the Trimble mill at Silver City; the total production from both of these milling operations was 1,158 ounces of gold and 841 ounces of silver. In the same district a little development work was done at the Jack Pot mine, which had been closed for about 15 years, and 1 car of 37-ounce silver ore was shipped to the Midvale (Utah) smelter. Lessees at the San Rafael mine in the Westgate district shipped 359 tons of silver-lead ore to the smelter at Midvale.

Clark County.—Gold and silver were the chief metals produced in Clark County in 1934; 9 mines, each with an output of 100 to 1,000 ounces of gold, yielded over 80 percent of the county total. Simac Mines, Inc., in the Eldorado district was the largest producer of gold and silver in the county; the company began production at its property 41 miles east of Las Vegas and ran its 50-ton flotation mill, completed in July, until the end of the year; about 4,000 tons of ore were treated, and 46 tons of concentrates were shipped to the Midvale smelter. Small shipments of high-grade gold ore were made from the Techatticup and the Cole and Stoeckly mines in Eldorado Canyon to the Midvale smelter. In the Searchlight district Hughes and Collins cyanided about 2,000 tons of old tailings purchased from various mines and shipped precipitates to the Midvale smelter. In the same district the Mollin Investment Co. shipped 71 tons of concentrates from ore from the Quartette mine. The Cyrus Noble mill, equipped for amalgamation and cyanidation, operated irregularly on custom ore throughout the year. Lessees on the Blossom group about 24 miles east of Nipton, Calif., shipped to various custom mills. The Western Consolidated Gold Mines, Inc., milled a small tonnage of ore and shipped bullion, precipitates, and a small lot of concentrates to smelters. In the Yellow Pine district the California Molybdenum Corporation built a 50-ton concentration mill at the Shenandoah mine and treated about 4,750 tons of lead-zinc ore; approximately 120 tons of concentrates were shipped to the Selby (Calif.) smelter, and concentrates totaling about 120 tons were shipped to the Great Western Electro Chemical Co., the Selby plant of the American Smelting & Refining Co., and the Ozark Smelting Co. From the Red Cloud mine 36 tons of crude ore were shipped to the Midvale smelter, with a return of 56 ounces of gold and 4 ounces of silver. The Keystone Barefoot Mines Co. began to build a 50-ton amalgamation-flotation plant at its mines 20 miles west of Jean; about 600 feet of development work were done during the year, and 108 tons of ore were shipped to the Garfield and Midvale smelters, with a return of 483 ounces of gold, 84 ounces of silver, and about 1 ton of copper. The Golden Chariot mine in the same locality was operated throughout the year and handled 296 tons of ore and old tailings from which 324 ounces of gold, 95 ounces of silver, and approximately 1 ton of copper were recovered. In the Crescent district Scott Mines, Inc., was the largest producer of gold; about 230 tons of crude ore were milled or shipped to smelters.

Douglas County.—There was little mining in Douglas County in 1934. The principal production was gold, and it did not exceed 150 ounces. Lessees at the Laughborough (Side Track) mine about 10 miles westerly from Hudson in the Wellington district shipped 72 tons of ore to the Midvale smelter with a return of 67 ounces of gold and 76 ounces of silver; this mine was the largest producer in the county.

Elko County.—The principal metals produced in Elko County in 1934 were gold and silver. Gold Circle was the chief producing district, and the Elko Prince mine of the Gold Circle Consolidated Mines 36 miles northeast of Red House was the largest producer of gold and silver in the county. The mine is developed by a 900-foot vertical shaft and 12,000 feet of drifts and crosscuts and is equipped with a 75-ton continuous-decantation cyanide plant, in which approximately 2,800 tons of ore were treated. The Buena Gold Mines, Inc., rebuilt its 15-ton amalgamation mill at the Esmeralda and Coots claims in the Gold Circle district and operated it approximately 9 months of the year; about 800 tons of ore were milled. The Miners Gold Mining Co. operated its property 45 miles south of Golconda in the same district 10 months of the year; 235 tons of ore shipped to the Garfield smelter returned 398 ounces of gold and 6,866 ounces of silver. The Sleeping Beauty mine of the East Standard Mining Co. about 50 miles north of Winnemucca in the same district treated about 900 tons of ore in its 40-ton amalgamation mill, built during the year; 49 tons of concentrates were shipped to the Garfield smelter, and 121 ounces of gold and 97 ounces of silver were recovered. In the Delano district the Delno Mining & Milling Co. shipped to the International smelter at Tooele, Utah, from its Delno mine 37 miles northwest from Montello approximately 1,600 tons of silver-lead ore averaging about 20 ounces of silver and 390 pounds of lead per ton; in February the property was sold under bond and lease to the United Metals Co., which operated it the remainder of the year. The Jackson mine 10 miles north of Tecoma made a fair-size production of silver and lead; concentrates were shipped to the International Smelting Co. at Tooele. In the Jarbidge district about 200 tons of gold ore from the Blizzard mine were milled in a leased 5-stamp mill about 1 mile from the mine; concentrates were shipped to the Midvale smelter.

Esmeralda County.—The value of the metal output of Esmeralda County, one of the chief gold-producing counties in the State in 1934, was largely in gold and silver. The General Metals Recovery Corporation, operating on old tailings at the Tonopah Mining Co. property at Millers, constructed a 600-ton cyanide plant and placed it in operation in September. After the tailings, reclaimed by an electric shovel and transferred to ore bins by conveyors, were ground in ball mills the pulp was agitated, thickened, and treated by countercurrent decantation; about 43,000 tons of tailings were cyanided and the precipitates shipped to the Selby smelter. In the Desert district the

Mammoth and Last Hope claims 14 miles north of Gilbert Junction were operated under lease by the Gilbert Mammoth Gold Mines Co.; from 1,600 tons of ore treated by amalgamation and a small shipment of crude ore sent to the Garfield smelter, about 190 ounces of gold and 840 ounces of silver were recovered. The mill operated only 6 hours per day during 1934 due to shortage of water. The property of the Tonopah Divide Mining Co., operated by various leasers, was the largest producer of gold and silver in the Divide district. The mine is developed by a 1,400-foot vertical shaft, 13,000 feet of drifts, and a 500-foot adit; the ore was shipped to the Garfield smelter. The Grimes Divide Mining Co. and Brougher Divide Mining Co., also in the Divide district, each made a small production of gold and silver from ore shipped to the Garfield smelter. In the Goldfield district Bradshaw Syndicate, Inc., acquired the lease on the old tailings dump of Goldfield Consolidated Mines Co. and expended $40,000 in improving the cyanide plant formerly operated by Bradshaw, Inc. The capacity of the plant was increased from 1,000 to 1,300 tons by adding two 30- by 12-foot thickeners, installing a new pumping plant, and increasing the capacity of accessory equipment. The tailings were pulped, pumped to thickeners, and filtered in Butters filters, and the pregnant solution was precipitated by zinc dust; 359,000 tons of old tailings were treated, and the precipitates were shipped to the Selby smelter. The Goldfield Consolidated Mines Co. shipped about 1,900 tons of ore to the Garfield smelter and made a notable output of gold and silver. Other properties in the Goldfield district with fair-size outputs of the precious metals were the Sandstorm Kendall Consolidated Mining Co., Goldfield Deep Mines Co. of Nevada, and Jumbo Extension Co. The Mary mine in the Silver Peak district was the largest producer of gold in Esmeralda County; some of the ore was treated in the 50-ton mill of the Black Mammoth Consolidated Mining Co., some was shipped crude to the Garfield smelter, and the concentrates and bullion were shipped to the Selby smelter. The Imperial Development Co., Ltd., treated about 6,000 tons of ore from the Imperial mine 17 miles south of Silver Peak in its 30-ton cyanide plant and shipped the bullion to the San Francisco Mint. The ore, ground to 10-mesh, was percolated in leaching tanks and the pregnant solution precipitated on zinc shavings; a 105-hour leaching cycle was employed. The Los Angeles Rock & Gravel Corporation operated the Tule Canyon gold mine, a placer in the Lida (or Tule Canyon) mining district, 10 months of the year and made a fair-size output of gold; about 5,500 cubic yards of gravel were handled by a power shovel and screening plant.

Eureka County.—The Eureka and Lynn were the leading producing districts in Eureka County in 1934. Lessees operated the property of the Richmond Eureka Mining Co. in the Eureka district and shipped over 50 cars of ore to the Midvale smelter, with an average recovery of 0.41 ounce of gold, 3.5 ounces of silver, 6.4 pounds of copper, and 100 pounds of lead per ton. In the same district Cardinalli and Frank operated the mine of the Eureka Smelting & Refining Co. under lease and shipped 595 tons of ore to various Utah smelters, with a return of 98 ounces of gold, 4,323 ounces of silver, and 20 tons of lead. The Lynn Big Six mine 22 miles northwest of Carlin, under lease to C. W. Reese, was the largest gold producer in the Lynn district, with an output of approximately 600 ounces; some of the ore was crushed in a 10-ton ball mill and amalgamated, but a larger tonnage was shipped crude to smelters in Utah. A few hundred ounces of gold were recovered from small placer operations in the Lynn district; the principal producers were the Bull Dog No. 1, Arrowhead, and Beaver Crown claims.

Humboldt County.—Gold and silver were the principal metals produced in Humboldt County in 1934, and the output came entirely from small producers; the recovery was largely by amalgamation, and no mine yielded as much as 500 ounces of gold. In the National district the Buckskin mine, the largest gold producer in the county, was taken over by the Nevada Lucky Tiger Mining Co. in June, and the flotation plant at the property was remodeled into a 40-ton cyanide plant which was placed in operation November 12; the ore, ground to 100-mesh, was agitated and cyanided by countercurrent decantation, and the filtered solutions were precipitated on zinc dust. Another leading producer was the Ashdown mine (Vicksburg district), where a 25-ton amalgamation mill was run intermittently from February to November. The Nevada Consolidated Mines Co. started to build a 10-ton concentration mill to serve its Tacoma, Seattle, and Pansy Lee mines in the Barret Springs district and did about 600 feet of development work during the year; about 50 tons of ore were shipped to the Tooele smelter, with a return of 33.5 ounces of gold, 123 ounces of silver, and 2 tons of lead.

Lander County.—Lander County made a fair output of gold and silver in 1934; most of the work done, both at lode and placer mines, was by lessees, and most of the ore mined was shipped to Utah smelters. Battle Mountain was the principal producing district and the Copper Canyon Mining Co. the largest gold producer in the county. The company output came from its Copper Canyon and Copper Basin claims 7 and 17½ miles, respectively, southwest of Battle Mountain; the mines were operated throughout the year by lessees and a small company crew, and the ore was shipped crude to smelters at Garfield and Tooele. Besides gold, the company made a fair output of silver and a small production of copper. In the same district J. A. Madison and associates shipped ore from the No Money, Gold Cash, and Bailey Day group of claims to smelters at Garfield and Tooele and made a fair production of gold and a small output of silver and copper. The Grand Hills Mining Co. operated the Jim Dahl placer 17 miles south of Battle Mountain in the same district and handled about 5,000 cubic yards of gravel with two 1¼-yard gasoline shovels; the excavated material was hauled by trucks to a screening and washing plant in which the gold was recovered by four Ainlay centrifugal bowls. The Betty O'Neal mine in the Lewis district was operated by leasers and was the outstanding producer of silver in Lander County; about 40 cars of silver ore were shipped to the Midvale smelter. In the Bullion district C. W. Adeen and associates operated the Independence placer 1¼ miles south of Tenabo, using a dry-washing machine with a daily capacity of 150 cubic yards; about 4,650 cubic yards of gravel were handled, with a yield of 181 fine ounces of gold. A recovery of more than 96 percent of the gold was reported.

Lincoln County.—Gold, silver, copper, lead, and zinc were produced in Lincoln County in 1934, the output coming from the Caliente, Comet, Eagle Valley, Ferguson, Groom, Jack Rabbit, Pioche, and

Tem Piute districts. The Caliente Cobalt Mining Co., with a small production of gold, silver, copper, and lead (from 76 tons of ore shipped to the Garfield smelter), was the largest producer in the Caliente district. In the Comet district the Pan American Mining Co. sold its property to the Comet Coalition Mines Co. in July; the latter company shipped a few cars of silver ore averaging about 33 ounces of silver and 100 pounds of lead per ton to the Tooele smelter. In the Ferguson district the Magnolia mine of the Delamar Exploration Co. was operated by lessees, and 1,524 tons of ore yielding 1,720 ounces of gold and 5,306 ounces of silver were shipped crude to smelters at Garfield and Midvale. In the same district the Caliente Cyaniding Co. was erecting a 150-ton cyanide plant to treat tailings on the Golden Eagle and Monatare claims; about 24,400 tons of tailings were cyanided and the precipitates shipped to smelters at Selby and Garfield, and the company also shipped crude about 250 tons of gold ore to the Garfield smelter. The Bristol Silver Mines Co. did considerable development work on its property in the Jack Rabbit district. The mine is opened by a 70° inclined shaft 1,750 feet deep; over 2,500 feet of development work were done in 1934. The mine was operated the entire year and was one of the largest producers of silver in the State; about 12,700 tons of silver-lead ore were mined and shipped to the International Smelting Co. at Tooele. In the Pioche district active mining and development work were done; the leading producers in order of value of output were the Combined Metals Reduction Co., Pioche Mines Consolidated, Prince Consolidated Mining Co., and lessees on the property of the Manhattan Copper & Gold Mining Co. The Combined Metals Reduction Co. operated the entire year and shipped ore from its Amalgamated Shaft No. 1 to its flotation plant at Bauer, Utah; the ore is a lead-zinc-silver ore, and the company was the largest producer of both lead and zinc in the State, as well as an outstanding producer of silver. The Pioche Mines Consolidated operated under lease the Amalgamated Pioche Mines & Smelter Corporation property the entire year and the Daly East mine from September to December 31; approximately 1,300 tons of silver ore from the former property were shipped crude to the Garfield and Midvale smelters, and about 740 tons of gold-silver ore from the latter mine were sent to the Garfield smelter. The Prince Consolidated Mining Co. operated the Prince mine, which is opened by a vertical shaft 835 feet deep and has about 5,000 feet of drifts, and development work during 1934 comprised 300 feet of drifts and raises; over 700 tons of silver-lead ore were shipped to the International Smelting & Refining Co. at Tooele. Lessees operated the Half Moon mine of the Manhattan Copper & Gold Mining Co. 2½ miles southeast of Pioche and shipped 140 tons of silver-lead ore to the smelters at Murray and Garfield, Utah. The Sterling mine in the Tem Piute district was worked by lessees who shipped about 270 tons of silver ore to smelters at Midvale and Garfield.

Lyon County.—In Lyon County the principal metal production in 1934 came from the Silver City district, ore from which was treated at the Donovan and Trimble mills. The five leading gold producers in the district were the Dayton, Spring Valley, Esher Group, Haywood, and Santiago mines. The Dayton mine operated by the Dayton Consolidated Mining Co. is equipped with a 120-ton all-sliming cyanide plant; the mine and mill were operated from March 1 to December 31, and 6,094 ounces of gold and 22,210 ounces of silver were recovered from 29,394 tons of ore. The Spring Valley Mines Co. operated the Spring Valley mine, which is opened by a vertical shaft 200 feet deep and has about 600 feet of drifts; over 2,000 tons of gold ore were mined, part of which was treated by amalgamation at the Trimble mill and the rest by cyanidation at the Dayton mill, both at Silver City. The Haywood mine of the St. Joe Consolidated Mines Corporation produced over 1,000 tons of gold ore, which was treated by amalgamation at the Trimble mill. The Santiago mine was operated under lease by Hardwick and Trimble, and approximately 400 feet of drifts, crosscuts, and raises were driven during the year; about 1,250 tons of ore were mined and treated by amalgamation at the Trimble mill, with a recovery of 246 ounces of gold and 223 ounces of silver. Some of the other producers in the Silver City district were the Pedroli, South Comstock Gold Mines, Inc., and Cosmopolitan. The Pedroli mine produced about 140 tons of gold ore, which was treated at the Trimble mill. The South Comstock mine was operated during the spring only; it is equipped with a 60-ton amalgamation and flotation mill, and the concentrates were sold to the Selby smelter and the bullion went to the San Francisco Mint. The Cosmopolitan mine was operated about 4 months; 40 tons of gold ore were produced and were treated by amalgamation at the Trimble mill. The Virginia Hills mine in the Talapoosa district shipped about 10 cars of gold ore to the Garfield smelter. Some small lode and placer operations were carried on in the Yerington district.

Mineral County.—The value of metals produced in Mineral County in 1934 was almost entirely in gold and silver, although some lead was recovered from ores shipped from the Silver Star and Hawthorne districts; virtually all the ore mined in the county was gold ore, which was treated either in the Kernick mill at Sodaville or shipped crude to smelters. The principal activity was in the Silver Star district at the Kernick mine and mill, which were taken over by the W. M. Mining & Milling Co.; the mine was operated from February to June 11, and the 30-ton amalgamation and flotation mill also served as a custom plant. The Douglass mine in the same district 8 miles southwest of Mina was the next largest gold producer in the county. Ore from this mine was treated in the Kernick mill and also shipped crude, with some concentrates, to the Garfield and Midvale smelters; bullion was sold to the Nevada Testing Laboratory at Reno and the San Francisco Mint. Some of the crude ore shipped assayed 0.42 and 0.49 ounce gold and 0.6 and 0.5 ounce silver to the ton. The Moho mine in the Silver Star district was active, and one shipment of 16 tons of ore to the Midvale smelter yielded 8.16 ounces of gold, 121 ounces of silver, and less than 1 ton of lead; a cyanide plant was reported in operation at the mine later in the year. Gold ore from the Sunnyside group in the Gold Range section of the Silver Star district 8 miles southwest of Mina was milled at the Kernick mill; 72 tons of ore yielded $1,372 in gold, and 1,440 pounds of concentrate yielded $114 in gold. Some dump ore was sold outright to the Kernick mill, and 55 tons of mine ore were shipped to the Garfield smelter; concentrates and bullion from 120 tons of dump ore were shipped to the Selby smelter. In the Hawthorne district the Ashby Gold Mines, Inc., shipped several cars of good gold ore to the Midvale smelter from its mine 16 miles southeast of Hawthorne and from the Gold Bug group of 12 lode claims 10 miles southeast of Hawthorne; one shipment of 27 tons of ore yielded 38.42 ounces of gold and a small quantity of silver. In the Pilot Mountain district the Belleville mine produced about 70 tons of ore which was treated in the 3-ton amalgamation mill on the property; the ore carried gold with little silver and averaged about $40 a ton. Gold ore from the Montreal mine in the Fitting district 5 miles east of Kinkead was treated in the amalgamation mill on the property, and some was shipped crude to a smelter; the 10 tons mined yielded $1,244 in gold.

Nye County.—Nye was one of the two leading counties in the State in 1934 in total value of gold, silver, copper, lead, and zinc produced; the largest part of the gold and silver output was from smelted ore, although several amalgamation mills, including the Kane custom mill in the Manhattan district which treated more ore than in 1933, and cyanide plants treating ore or tailings made important contributions.

In the Round Mountain district Nevada Porphyry Gold Mines, Inc., operated its Sunnyside and Fair View mines throughout 1934 and made an important output of gold from its 200-ton 30-stamp amalgamation mill; the property 60 miles northeast of Tonopah is developed by an inclined shaft 1,200 feet deep, and approximately 7,600 feet of development work were done during the year. The company also operated its Hillside mine in the Round Mountain district with a newly installed electric shovel and screening plant in addition to the old hydraulic equipment and was one of the largest producers of placer gold.

In the Manhattan district the mine of the White Caps Gold Mining Co. was in continuous operation under the leasing system throughout the year, the ores being shipped as previously to the Garfield smelter. The cyanide plant was operated as long as the weather permitted and treated tailings for 7 months; enough tailings remain to supply the plant for another season. The mine production (by leasers) was 6,028 tons of ore yielding 6,095 ounces of gold, an average of slightly over an ounce per ton, and the yield from the cyanidation of 23,055 tons of tailings was 2,067 ounces of gold. This company made the largest output of gold in the county and the second largest in the State. Some placer mining also was carried on in the Manhattan district.

In the Tonopah district a final clean-up of the mill of the Tonopah Mining Co. of Nevada was completed, and ore from the property, worked throughout the year by various sets of leasers, was shipped to the Garfield smelter. The Thirty-third Annual Report of the company (for the year ended Dec. 31, 1934) states:

Leasing operations were carried on continuously during the year at the property in Tonopah. Due to the increase in the price of gold and silver, the number of leasers increased, and at all times during the year all available equipment was constantly in use. A total of 8,972.473 tons was produced, containing 4,929.116 ounces of gold and 431,021.56 ounces of silver, the total gross value being $451,333.20. Royalty amounting to $85,634.78 was collected from this source, or $9.54 per ton. Total net profits resulting from leasing operations amounted to $63,104.46. * * * The General Metals Recovery Corporation, lessee of the company's tailings, located at Millers (Esmeralda County), Nevada, have entirely reconstructed their plant and resumed operations on October 1, 1934, and have operated continuously since that date. * * * It is impossible to estimate how long leasing operations can be continued at a profit. No large bodies of ore have been found, but occasionally small amounts of high-grade ore are found.

It is safe to say, however, that profitable leasing operations will continue for some indefinite time.

Active search for new properties was carried on during the year, and the Tonopah Mining Co. of Nevada was the third largest producer of gold and the second largest producer of silver in Nye County. The Belmont mine of the Tonopah Belmont Development Co. at Tonopah was leased in October to H. D. Budelman for subleasing, and some 40 sets of leasers worked in the mine during the remainder of the year. The property is developed by two vertical shafts, 1,127 and 1,718 feet deep, respectively, and by many miles of drifts, crosscuts, raises, and winzes. About 585 tons of ore were produced and shipped crude to the Garfield smelter, with a recovery of 127 ounces of gold and 12,317 ounces of silver. Tests were made by the American Cyanamid Co. early in 1934 on the mill tailings at Tonopah, amounting to over 1,500,000 tons, to ascertain whether they can be treated successfully by flotation. The land, water rights, and mill tailings at the site of the old mill at Millers were sold during the year. Other sizable operations in the Tonopah district were those of the Tonopah Divide Mining Co. and the Tonopah Extension Mines, Inc. The latter company shipped 1,294 tons of silver ore to the Garfield smelter and 44 tons of material from cleaning up its mill to the Selby smelter, with a total recovery of 584 ounces of gold and 55,683 ounces of silver.

At the Tybo property of the Treadwell Yukon Co., Ltd., in the Tybo district milling was resumed April 15 and continued throughout the year. Some alterations were made in milling equipment, and stopes were opened on the Ely ore shoot on the bottom level of the mine. Shaft sinking was resumed toward a new station 150 feet below the present bottom (1,010-foot) level. The work necessary for resumption of operations at the Tybo mine was begun January 31, and by April 11 the mine was entirely pumped out; 3,480 feet of development work, comprising 2,636 feet of drifts, 615 feet of crosscuts, and 229 feet of raises, were done during the year. Between April 15 and the end of the year 73,266 tons of ore, with an average assay of 0.025 ounce gold, 12.35 ounces silver, 7.08 percent lead, and 5.21 percent zinc, were mined and milled, from which were produced 6,399.78 tons of lead concentrate, with an assay per ton of 0.094 ounce gold, 102.17 ounces silver, 68.48 percent lead, and 2.76 percent zinc, and 6,207.99 tons of zinc concentrate, with an assay per ton of 0.029 ounce gold, 10.75 ounces silver, 2.30 percent lead, and 48.79 percent zinc. In addition to the foregoing current production, 2,693.29 tons of zinc concentrate assaying 0.036 ounce gold, 11.58 ounces silver, 2.29 percent lead, and 46.02 percent zinc were sold during the year; this output, together with 2,430.26 tons sold during 1933, was the accumulated unsold zinc concentrate on hand when the mine was shut down in October 1931. The Tybo property was the largest producer of silver and the second largest producer of lead and zinc in the State.

Except for the mines mentioned, virtually the entire output of Nye County was from small mines, most of which shipped their ores crude to smelters.

Pershing County.—Gold and silver were the chief metals produced in Pershing County in 1934 and came largely from various small lode and placer operations in the Kennedy, Rochester, Rosebud, Scossa, Seven Troughs, and Sierra districts. A little lead was recovered from silver-lead ores from the Rochester and Imlay districts. The Nevada State Gold Mining Co. in the Seven Troughs district was the largest gold producer in the county and shipped gold and silver bullion from its 100-ton cyanide plant to the San Francisco Mint and a few cars of ore to smelters at Midvale and Tooele. About 4,140 tons of dump ore from this property were treated by the Seven Troughs Leasing Syndicate, which erected a screening plant and reconditioned the cyanide plant at the property to treat such ore. Operations were not profitable and the lease was abandoned in May, after which the dump was worked by the L. M. & M. Syndicate which also operated the Signal Peak mine. About 11,875 tons of ore from the mine and 1,500 tons of dump ore were cyanided and yielded 2,497 ounces of gold and 7,230 ounces of silver. Other principal producers in Pershing County were the Gold Note mine of the Sterling group of claims in the Kennedy district and the Brown Palace mine in the Rosebud district.

Storey County.—The value of the mine output of Storey County was almost entirely in gold and silver, with a small quantity of lead recovered from the gold ores shipped to smelters. Nine mines and one tailings dump yielded in 1934 three times the lode-gold output of the county in 1933 (5,056 fine ounces) and approximately 284,000 fine ounces of silver (84,026 ounces in 1933). All the ore treated in 1934 came from the Comstock district (embracing the Flowery, Gold Hill, Silver Star, and Virginia City areas), which experienced one of the most important revivals in mining in the State. The Arizona Comstock Corporation, operating the Savage, Hale & Norcross, Chollar, and Potosi claims, all within the city limits of Virginia City, was the largest producer of gold and silver in the county. In June the capacity of the flotation mill was increased from 110 to 330 tons, and during the year 66,068 tons of ore assaying 0.1037 ounce gold and 3.563 ounces silver to the ton were milled. The mine was operated 12 hours a day and the mill 24 hours a day for 364 days. The Silver Hill mine in the Gold Hill area was the second largest producer in the county; the ore was milled in the Donovan amalgamation and cyanidation mill, which also treated custom ore. The mine is developed by an inclined shaft, and 400 feet of development work were done during the year. Ore from the Keystone mine, the fourth largest producer on the Comstock Lode, was hauled by truck to the Trimble amalgamation mill and the bullion shipped to the San Francisco Mint. About 550 feet of development work were done in the mine, which is opened by a 170-foot inclined shaft and 250 feet of drifts. The Consolidated Chollar Gould & Savage Mining Co. operated property 1 mile south of Gold Hill and treated 37,853 tons of gold ore in its flotation plant, which was enlarged from 50 to 150 tons daily capacity. The ore carries cerargyrite, argentite, pyrite, and gold, and the ore milled in 1934 assayed 0.08 ounce gold and 3.16 ounces silver to the ton. Treatment consisted of crushing to minus 1-inch mesh in jaw crusher, grinding to minus 40-mesh in 8-foot by 22-inch Hardinge ball mill in closed circuit with Dorr classifier, and floating in 12 Kraut cells; the tailings were scavenged by two Deister Plat-O tables, and the concentrate was cleaned in a 2-cell Kraut cleaner unit. Ore from the Browne mine 1 mile southwest of Gold Hill was treated in the Dayton Consolidated mill at Silver City, and 2,151 tons of ore yielded about $13 in gold and silver to the ton. The St. Louis mine was operated almost continuously throughout

1934; ore was treated at both the Trimble and Donovan mills, and tailings were sold to the Donovan mill. The mine is developed by adits of various lengths, and about 800 feet of development work were done during the year. At the Overland mine, 1½ miles southeast of Gold Hill nearly 6,275 tons of gold ore were mined and treated in the 25-ton stamp mill and 50-ton flotation plant, operated continuously except when closed for repairs. Ore from the Sutro Tunnel property 1 mile from Gold Hill was treated in the Donovan mill and also shipped crude to the Garfield smelter; the property is developed by an opencut, and the ore is oxidized. The Lynch tailings dump one-half mile from Virginia City was treated by flotation, and the concentrates were shipped to a smelter. Several mine dumps in the vicinity of Virginia City were cleaned up and yielded high values in gold. About 60 tons of ore were taken from the Mexican mill site, and the bullion recovered was shipped to the mint.

Washoe County.—The metal production of Washoe County in 1934 was confined to a small output of gold and silver of which a considerable part was derived from ore mined by lessees at the Texas No. 2 mine in the Olinghouse district and treated at the Springfield mill at Olinghouse. There was also a small production from the White Horse district.

White Pine County.—With an increase in the price of gold and a continued low price for copper, activity in White Pine County centered largely in the mining of gold ores, although the output of copper increased over 1933. White Pine was one of the two leading counties in Nevada in 1934 in value of metal output; the number of mines and leasing operations increased considerably, and the yield of gold and silver was virtually twice that in 1933. The Nevada Consolidated Copper Corporation was the largest producer of gold and copper in the State; its mines at Ruth in the Ely (Robinson) district and its smelter at McGill operated intermittently and far below capacity. The company gold production was derived as a byproduct in the treatment of its porphyry copper ores and from siliceous ore used as flux at its smelter and mined principally in the Lane City area. During the year the company improved the arrangement of its smelting plant, and a larger tonnage of siliceous ore was smelted than for several years; it has a 17,000-ton flotation plant and a 1,500-ton smelter. The Boston Ely and Smokey Group mines of the Consolided Coppermines Corporation were operated by leasers 8 months of the year, but no copper was produced. The company remained on a shut-down basis due to condition of the copper market and uncertainty as to the price of the metal; it is reported that about 3 months must elapse between the date of reopening the mines and the time when they can be expected to reach full capacity. The Cuba Consolidated Co. shipped a considerable tonnage of ore from its mine near Ely to a smelter in Utah. The Ely Gold Mining Co. shipped siliceous ore to the McGill smelter and was one of the leading producers of gold and silver in the county. Other shippers of siliceous ore to the McGill smelter were the Hayes, Keystone, Lucky Strike, Broecher, Diamond, Lincoln, Ohio, Morning Star, Silver Queen, Nevada Queen, and Siegel mines. Some lead ore was shipped from the Carbonate lead mine in the Duck Creek district. Placer gold was recovered in the Osceola district, but due to water shortage the yield was small.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO

(MINE REPORT)

By Chas. W. Henderson

SUMMARY OUTLINE

The total production of gold, silver, copper, lead, and zinc from New Mexico ores and gravels in 1934, in terms of recovered and estimated recoverable metals, was 27,307.01 fine ounces of gold, 1,061,775 fine ounces of silver, 23,630,000 pounds of copper, 18,729,000 pounds of lead, and 53,043,000 pounds of zinc. This output compares with a production in 1933 of 26,474.09 ounces of gold, 1,181,580 ounces of silver, 26,947,000 pounds of copper, 22,086,000 pounds of lead, and 61,848,000 pounds of zinc and shows an increase of 832.92 ounces in gold and decreases of 119,805 ounces in silver, 3,317,000 pounds in copper, 3,357,000 pounds in lead, and 8,805,000 pounds in zinc. There were 153 lode mines and 328 placers producing in 1934, an increase of 61 lode mines and 26 placers from 1933.

The total recorded production of gold, silver, copper, lead, and zinc (in terms of recovered metals) in New Mexico from 1848 to 1934, inclusive, has been 1,897,320 fine ounces of gold, 56,440,759 fine ounces of silver, 1,540,130,473 pounds of copper, 410,851,385 pounds of lead, and 843,181,394 pounds of zinc.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly United States Government prices.[1] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and

[1] The Treasury from February 1, 1934, through December 1934 has calculated all gold, and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U.S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1930–34, in terms of recovered metals

Year	Mines producing			Ore (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total		Fine ounces	Value	Fine ounces	Value
1930	88	5	93	2,971,441	32,370.42	$669,156	1,107,335	$426,324
1931	59	109	168	3,003,941	31,161.24	644,160	1,041,859	302,139
1932	87	378	465	1,464,718	23,208.05	479,753	1,142,351	322,143
1933	92	302	394	1,475,839	26,474.09	[1] 676,678	1,181,580	413,553
1934	153	328	481	1,397,709	27,307.01	954,380	1,061,775	686,400

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1930	65,150,000	$8,469,500	20,756,900	$1,037,845	65,529,000	$3,145,392	$13,748,217
1931	61,503,100	5,596,782	22,537,000	833,869	55,732,000	2,117,816	9,494,766
1932	28,419,000	1,790,397	20,227,000	606,810	51,186,000	1,535,580	4,734,683
1933	26,947,000	1,724,608	22,086,000	817,182	61,848,000	2,597,616	[1] 6,229,637
1934	23,630,000	1,890,400	18,729,000	692,973	53,043,000	2,280,849	6,505,002

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold and silver produced at placer mines in New Mexico, 1930–34, in terms of recovered metals

Year	Gold		Silver		Total value	Year	Gold		Silver		Total value
	Fine ounces	Value	Fine ounces	Value			Fine ounces	Value	Fine ounces	Value	
1930	63.66	$1,316	18	$7	$1,323	1933	1,399.15	[1] 35,762	160	$56	[1] $35,818
1931	406.59	8,405	59	17	8,422	1934	2,587.64	90,438	212	137	90,575
1932	1,270.28	26,259	181	51	26,310						

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold.—The mine production of recoverable gold in New Mexico was 27,307.01 fine ounces valued at $954,380 in 1934 compared with 26,474.09 ounces valued at $676,678 in 1933. San Miguel County (Pecos mine) produced 57.25 percent of the total in 1934, Catron 11.71 percent, and Grant 11.17 percent. The largest increases over

1933 were 1,257.07 ounces in Grant County, largely from increased activity in the Pinos Altos and Steeple Rock districts, 1,178.09 ounces in Sierra County, chiefly in the Hillsboro district, and 799.47 ounces in Colfax County, Mount Baldy district; the largest decrease was 3,792.30 ounces in San Miguel County. Lead-zinc ore yielded 57.25 percent of the total gold, dry and siliceous ore 28.00 percent, and copper ore 4.48 percent; placer mines yielded 9.48 percent compared with 5.28 percent in 1933. The increase in placer output was principally from operation of a drag line-Ainlay bowl installation in the Hillsboro district, Sierra County, and from small-scale operations in Lincoln County.

Silver.—The mine production of recoverable silver in New Mexico amounted to 1,061,775 fine ounces valued at $686,400 in 1934 compared with 1,181,580 ounces valued at $413,553 in 1933. San Miguel County produced 51.20 percent of the total in 1934, all from lead-zinc ore of the Pecos mine in the Willow Creek district; Grant County 34.15 percent, chiefly from the Central, Steeple Rock, and Pinos Altos districts; and Catron County 11.43 percent, all from the Mogollon district. Lead-zinc ore from Grant and San Miguel Counties yielded 77.34 percent of the total silver; dry and siliceous ore, chiefly from Catron and Grant Counties, 17.93 percent; copper ore, chiefly from Grant County, 2.17 percent; copper-lead ore, from Grant and Lincoln Counties, 2.06 percent; and lead ore, chiefly from Grant County, 0.47 percent.

Copper.—The mine production of recoverable copper in New Mexico amounted to 23,630,000 pounds valued at $1,890,400 in 1934 compared with 26,947,000 pounds valued at $1,724,608 in 1933. Chino Mines in the Central district, Grant County, operated at about 20 percent of capacity until closed in October and produced 82.40 percent of the State total in 1934; the only other important producers of copper in New Mexico were the Ground Hog and San Jose mines, Grant County, and the Pecos mine, San Miguel County. Copper ore yielded 82.65 percent of the total copper, lead-zinc ore 16.67 percent, and copper-lead ore 0.48 percent; only a small percentage was recovered from other types of ore.

Lead.—The mine production of recoverable lead in New Mexico amounted to 18,729,000 pounds valued at $692,973 in 1934 compared with 22,086,000 pounds valued at $817,182 in 1933. The chief lead-producing districts in both years were the Willow Creek, San Miguel County; Central, Grant County; and Magdalena, Socorro County. Lead-zinc ore yielded 95.65 percent of the total lead, copper-lead ore 2.65 percent, and lead ore 0.95 percent.

Zinc.—The mine production of recoverable zinc in New Mexico amounted to 53,043,000 pounds valued at $2,280,849 in 1934 compared with 61,848,000 pounds valued at $2,597,616 in 1933. The zinc-producing districts in 1934 were the Willow Creek in San Miguel County, the Central in Grant County, and the Magdalena in Socorro County. Zinc concentrates produced in 1934 totaled 56,906 tons and contained, as shipped, 1,702.23 ounces of gold, 145,199 ounces of silver, 988,374 pounds of copper, 1,439,997 pounds of lead, and 62,544,745 pounds of zinc. The average zinc content was therefore 54.95 percent.

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MINE PRODUCTION BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1934, by counties, in terms of recovered metals

County	Mines producing			Ore (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total		Fine ounces	Value	Fine ounces	Value
Catron	3		3	41,736	3,198.57	$111,790	121,357	$78,453
Colfax	7	12	19	2,931	1,146.61	40,074	150	97
Dona Ana	4		4	1,119	8.04	281	2,673	1,728
Grant	44	77	121	1,142,917	3,049.07	106,565	362,572	234,390
Hidalgo	32		32	1,655	675.33	23,603	10,386	6,714
Lincoln	8	95	103	853	1,041.66	36,406	512	331
Luna	3		3	79	.92	32	1,245	805
Otero		7	7		129.93	4,541	11	7
Rio Arriba		3	3		15.11	528	1	1
Sandoval	1		1	580	110.47	3,861	7,060	4,564
San Miguel	1		1	200,839	15,632.39	546,352	543,639	351,443
Santa Fe	5	73	78	83	234.42	8,193	99	64
Sierra	33	60	93	1,272	1,894.62	66,217	10,115	6,539
Socorro	10		10	3,640	161.00	5,627	1,949	1,260
Taos	2	1	3	5	8.87	310	6	4
	153	328	481	1,397,709	27,307.01	954,380	1,061,775	686,400
Total, 1933	92	302	394	1,475,839	26,474.09	[1] 676,678	1,181,580	413,553

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Catron	4,300	$344	1,000	$37			$190,624
Colfax	300	24					40,195
Dona Ana	1,900	152	63,700	2,357			4,518
Grant	21,826,600	1,746,128	5,829,100	215,677	18,218,000	$783,374	3,086,134
Hidalgo	35,600	2,848	19,500	721			33,886
Lincoln	4,400	352	13,900	514			37,603
Luna	200	16	49,100	1,817			2,670
Otero							4,548
Rio Arriba							529
Sandoval	200	16					8,441
San Miguel	1,733,000	138,640	12,286,000	454,582	33,693,000	1,448,799	2,939,816
Santa Fe	700	56	5,000	185			8,498
Sierra	15,200	1,216	3,400	126			74,098
Socorro	7,600	608	458,300	16,957	1,132,000	48,676	73,128
Taos							314
	23,630,000	1,890,400	18,729,000	692,973	53,043,000	2,280,849	6,505,002
Total, 1933	26,947,000	1,724,608	22,086,000	817,182	61,848,000	2,597,616	[1] 6,229,637

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67 + per ounce).

Gold and silver produced at placer mines in New Mexico in 1934, by counties, in fine ounces, in terms of recovered metals

County	Sluicing and hydraulic		Dry-land dredges [1]		Total	
	Gold	Silver	Gold	Silver	Gold	Silver
Colfax	73.21	8	29.51	4	102.72	12
Grant	86.35	22	247.90	34	334.25	56
Lincoln	394.19	42			394.19	42
Otero	48.48	5	81.45	6	129.93	11
Rio Arriba	15.11	1			15.11	1
Santa Fe	162.91	9	16.26	1	179.17	10
Sierra	288.19	19	1,142.11	60	1,430.30	79
Taos	1.97	1			1.97	1
	1,070.41	107	1,517.23	105	2,587.64	212
Total, 1933	1,049.03	134	350.12	26	1,399.15	160

[1] Drag-line and power-shovel excavators with sluices or special amalgamators.

MINING INDUSTRY

The Pecos mine of the American Metal Co. at the junction of Willow Creek and Pecos River, San Miguel County, continued to hold the rank it has held since 1927 as the largest producer of gold, silver, lead, and zinc in New Mexico, but its output of all four metals was less in 1934 than in 1933. Increases in gold production in other counties, however, more than offset the decrease in San Miguel and the State total output of gold increased in 1934, whereas the State output of the other metals, including copper, decreased in quantity. The other most important producers of metals in New Mexico in 1934 were Chino Mines at Santa Rita, Black Hawk Consolidated Mines Co. from operations at Mogollon and Hanover, Peru Mining Co. from its Pewabic mine at Hanover, and Asarco Mining Co. from the Ground Hog and San Jose mines near Hanover.

Details of the foregoing and other operations will be found under the following review by counties and districts.

ORE CLASSIFICATION

Ore sold or treated in New Mexico in 1934, with content in terms of recovered metals

Source	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous gold ore	9,096	3,807.75	13,430	35,300	83,150	
Dry and siliceous gold and silver ore	44,263	3,801.11	156,847	5,400	4,900	
Dry and siliceous silver ore	2,247	36.76	20,133	2,900	49,400	
	55,606	7,645.62	190,410	43,600	137,450	
Copper ore	1,000,972	1,223.92	23,082	19,529,550	1,900	
Copper-lead ore	1,176	1.20	21,850	114,400	496,850	
Lead ore	807	216.24	5,020	4,450	177,800	
Lead-zinc and zinc ores	339,148	15,632.39	821,201	3,938,000	17,915,000	53,043,000
	1,342,103	17,073.75	871,153	23,586,400	18,591,550	53,043,000
Total, lode mines	1,397,709	24,719.37	1,061,563	23,630,000	18,729,000	53,043,000
Total, placers		2,587.64	212			
	1,397,709	27,307.01	1,061,775	23,630,000	18,729,000	53,043,000
Total, 1933	1,475,839	26,474.09	1,181,580	26,947,000	22,086,000	61,848,000

METALLURGIC INDUSTRY

All markets for New Mexico ore and concentrates are outside the State. In 1934 copper ore and concentrates and dry and siliceous ores and concentrates were sold to the American Smelting & Refining Co. copper plant at El Paso, Tex., and to the Copper Queen copper smelter at Douglas, Ariz., and lead ore and concentrates were sold to the American Smelting & Refining Co. lead plant at El Paso, Tex. Zinc concentrates were shipped to the American Smelting & Refining Co. natural-gas retort plant at Amarillo, Tex.; to the Illinois Zinc Co. retort plant at Peru, Ill.; to the American Zinc Co. of Illinois, East St. Louis, Ill.; to the American Metal Co. producer-gas retort plant at Langeloth, Pa.; and to the American Metal Co. natural-gas retort plant at Blackwell, Okla. Zinc-lead sulphide ore was shipped to the Ozark Smelting & Mining Co. zinc-lead pigment plant at Coffeyville, Kans. Small lots of gold ore and concentrates were sold to the Golden Cycle mill at Colorado Springs, Colo. Gold bullion and gold-silver precipitates were sold to the American Smelting & Refining Co. refinery at Selby, Calif.

The selective flotation method was used at all important concentration mills in New Mexico in 1934 except the Little Fanney mill, Mogollon district, Catron County, where gold and silver ores are concentrated. The flotation method was discontinued here in 1934 and the mill remodeled back to cyanidation after having been changed from cyanidation to flotation in 1931.

The following table gives the names of the flotation mills active in 1934 and the location, county, rated capacity, type of ore treated, and type of concentrate produced.

Flotation mills in New Mexico active in 1934

Name of company or mill	Location of mill	County	Rated capacity (short tons per 24 hours)	Type of ore treated	Type of concentrate produced
Chino Mines	Hurley	Grant	[1] 15,000	Copper-gold-silver	Copper-gold-silver.
Combination (Black Hawk).	Hanover	do	[2] 250	Zinc-lead-copper-silver.	Zinc, lead-silver, copper-silver.
Little Fanney [3]	Mogollon	Catron	[3] 50 to 70	Gold and silver	Gold and silver.
Molybdenum Corporation of America.	Red River and Sulphur Creek.	Taos	40	Molybdenum	Molybdenum.
Pecos (American Metal Co.).	Alamitos Canyon.	San Miguel	[4] 600	Zinc-lead-copper-gold-silver.	Zinc, lead-copper-gold-silver.
Peru Mining Co	Wemple	Luna	[5] 300	Zinc	Zinc.

[1] 6,805 tons for 147 days.
[2] 200 tons for 344 days.
[3] Changed to cyanidation May 1, 1934.
[4] 550 tons for 365 days.
[5] 298 tons for 223 days.

Mine production of metals in New Mexico in 1934, by methods of recovery, in terms of recovered metals

Method of recovery	Material treated	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Ore amalgamated	3,149	567.16	259			
Ore cyanided	26,889	2,185.16	74,272			
Concentrates cyanided	186	600.27	28			
Concentrates smelted	[1] 110,512	17,750.29	887,008	23,411,650	17,515,000	51,911,000
Ore smelted	14,744	3,616.49	99,996	218,350	1,214,000	1,132,000
Placer		2,587.64	212			
		27,307.01	1,061,775	23,630,000	18,729,000	53,043,000
Total, 1933		26,474.09	1,181,580	26,947,000	22,086,000	61,848,000

[1] From 1,352,927 tons of ore treated at concentrating mills and 2,780 tons of ore first amalgamated.

Gross metal content of New Mexico concentrates produced in 1934, by classes of concentrates [1]

Class of concentrates	Concentrates produced (dry weight) [1]	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold	[1] 41	120.34	91	734	5	
Dry gold and silver	255	1,097.92	46,361	1,974	2,043	
Copper	26,304	898.54	18,158	20,081,881	49	
Copper-lead	9,879		277,562	2,878,696	5,963,845	2,431,211
Lead	17,127	13,931.26	434,570	1,251,824	13,702,931	3,312,660
Zinc	56,906	1,702.23	145,199	988,374	1,439,997	62,544,745
	[1] 110,512	17,750.29	921,941	25,203,483	21,108,870	68,288,616
Total, 1933	130,016	24,413.59	1,240,734	29,147,355	24,519,922	79,598,526

[1] Exclusive of 186 tons of dry gold concentrates cyanided containing 627.90 ounces of gold and 54 ounces of silver.

Mine production of metals from New Mexico concentrates in 1934, by counties, in terms of recovered metals [1]

County	Ore treated at concentrating mills	Concentrates and recovered metal					
		Concentrates produced [1]	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Catron	14,913	252	1,092.66	46,131	1,900	1,000	
Colfax		[2] 24	62.80	13	300		
Dona Ana	1,065	139	1.10	1,206	1,000	46,000	
Grant	1,135,580	[3] 56,084	901.99	295,426	21,675,000	5,182,000	18,218,000
San Miguel	200,839	53,993	15,632.39	543,639	1,733,000	12,286,000	33,693,000
Sierra	530	20	59.35	593	450		
	1,352,927	[1] 110,512	17,750.29	887,008	23,411,650	17,515,000	51,911,000
Total, 1933	1,462,910	130,016	23,287.96	1,140,281	26,802,677	20,115,900	59,836,000

[1] Exclusive of 186 tons of concentrates (186 tons from Colfax County and 243 pounds from Socorro County) cyanided yielding bullion containing 600.27 ounces of gold and 28 ounces of silver.
[2] From 2,700 tons of ore treated at gold and silver mills equipped for amalgamation and concentration.
[3] Includes 2 tons of concentrates from 80 tons of ore treated at gold and silver mills equipped for amalgamation and concentration.

Gross metal content of New Mexico crude ore shipped to smelters in 1934, by classes of ore

Class of ore	Ore	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous gold	5,488	2,425.09	13,024	37,183	164,961	
Dry and siliceous gold and silver	2,525	612.98	36,311	3,845	6,784	
Dry and siliceous silver	1,047	35.43	18,625	2,200	7,088	
Copper	572	325.67	5,241	61,987	3,644	
Copper-lead	1,176	1.20	21,850	144,877	764,899	
Lead	807	216.24	5,020	6,654	198,051	
Lead-zinc	3,129				639,028	1,363,801
	14,744	3,616.61	100,071	256,746	1,784,455	1,363,801
Total, 1933	9,919	1,121.98	40,837	175,161	2,505,397	2,515,540

Mine production of metals from New Mexico crude ore shipped to smelters in 1934, by counties, in terms of recovered metals

County	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Catron	33	15.64	983	2,400		
Colfax	2	2.50	2			
Dona Ana	54	6.94	1,467	900	17,700	
Grant	7,217	1,770.37	67,070	151,600	647,100	
Hidalgo	1,640	665.15	10,288	35,600	19,500	
Lincoln	704	486.17	409	4,400	13,900	
Luna	79	.92	1,245	200	49,100	
Sandoval	580	110.47	7,060	200		
Santa Fe	68	17.54	86	700	5,000	
Sierra	732	381.99	9,438	14,750	3,400	
Socorro	3,635	158.80	1,948	7,600	458,300	1,132,000
	14,744	3,616.49	99,996	218,350	1,214,000	1,132,000
Total, 1933	9,919	1,121.89	40,835	144,323	1,970,100	2,012,000

REVIEW BY COUNTIES AND DISTRICTS

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1934, by counties and districts, in terms of recovered metals

County and district	Number of mines producing		Ore sold or treated	Gold			Silver			Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total	Lode	Placer	Total				
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Catron County: Mogollon	3		41,736	3,198.57		3,198.57	121,357		121,357	4,300	1,000		$190,624
Colfax County: Mount Baldy	7	12	2,931	1,043.89	102.72	1,146.61	138	12	150	300			40,195
Dona Ana County: Organ	4		1,119	8.04		8.04	2,673		2,673	1,900	63,700		4,518
Grant County:													
Burro Mountain	3		597	85.32		85.32	10,477		10,477	5,900	900		10,260
Central	19	4	1,137,259	1,060.60	96.62	1,157.22	318,896	14	318,910	21,790,100	5,692,500	18,218,000	2,983,814
Eureka [1]	1		10	.09		.09	161		161	100	400		130
Gold Hill [1]	3		228	100.60		100.60	113		113	200	200		3,612
Pinos Altos	15	71	3,183	1,046.72	99.46	1,146.18	11,558	25	11,583	28,600	134,400		54,808
Steeple Rock	2		1,617	421.49		421.49	21,141		21,141	1,700	500		28,553
White Signal	1	2	23		138.17	138.17	170	17	187		200		4,957
Hidalgo County:													
Eureka [1]	6		632	372.32		372.32	425		425	7,650	300		13,911
Gold Hill [1]	1		50	32.50		32.50	3		3				1,138
Lordsburg	23		773	243.89		243.89	2,998		2,998	27,950	19,200		13,408
San Simon	2		200	26.62		26.62	6,960		6,960				5,429
Lincoln County:													
Gallinas Mountains	1		30	.29		.29	221		221	4,400	13,850		1,017
Jicarilla		84			327.81	327.81		26	26				11,474
Nogal	2	8	111	138.40	56.91	195.31	130	16	146		50		6,922
White Oaks	5	3	712	508.78	9.47	518.25	119		119				18,190
Luna County:													
Florida Mountains	1		38				170		170	200	15,000		681
Tres Hermanas	2		41	.92		.92	1,075		1,075		34,100		1,989
Otero County: Orogrande		7			129.93	129.93		11	11				4,548
Rio Arriba County: Headstone		3			15.11	15.11		1	1				529
Sandoval County: Cochiti	1		580	110.47		110.47	7,060		7,060	200			8,441
San Miguel County: Willow Creek	1		200,839	15,632.39		15,632.39	543,639		543,639	1,733,000	12,286,000	33,693,000	2,939,816
Santa Fe County:													
Los Cerrillos	2	25	68	31.93	51.30	83.23	89		89	700	5,000		3,208
San Pedro	3	48	15	23.32	127.87	151.19		10	10				5,290
Sierra County:													
Chloride	3		156	.43		.43	789		789	1,000	1,700		668
Kingston	2		3	.09		.09	49		49				35

Lake Valley	1		352	1.80		1.80	4,616		4,616	100	1,000		3,092
Las Animas (Hillsboro)	27	12	761	462.00	1,138.88	1,600.88	4,582	65	4,647	14,100	700		60,109
Pittsburg		48			291.42	291.42		14	14				10,194
Socorro County:													
Good Fortune	1		16				17		17	7,300	100		599
Magdalena	4		3,161	6.30		6.30	62		62	50	453,600	1,132,000	65,723
Mockingbird	1		4				6		6		4,500		170
Rosedale	1		58	13.20		13.20	115		115				535
San Mateo Mountains	2		396	139.30		139.30	1,748		1,748	250	100		6,023
Silver Hills	1		5	2.20		2.20	1		1				78
Taos County:													
Red River	1		5	.51		.51	5		5				21
Rio Grande River	1	1	(2)	6.39	1.97	8.36		1	1				293
Total New Mexico, 1934	153	328	1,397,709	24,719.37	2,587.64	27,307.01	1,061,563	212	1,061,775	23,630,000	18,729,000	53,043,000	6,505,002
1933	92	302	1,475,839	25,074.94	1,399.15	26,474.09	1,181,420	160	1,181,580	26,947,000	22,086,000	61,848,000	[3] 6,229,637

[1] District lies in both Grant and Hidalgo Counties.
[2] 250 pounds.
[3] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

CATRON COUNTY

Mogollon district.—The Black Hawk Consolidated Mines Co. operated the Little Fanney mill near Mogollon continuously in 1934 on ore from a group of mines locally known as the "Little Fanney and Johnson groups." The mill was remodeled in 1931 from cyanidation to flotation and changed back to cyanidation May 1, 1934. The ore in 1934 was extracted from the Little Fanney, Champion, Consolidated, and Little Charlie claims. Other producers in the Mogollon district were the Bearup and Ann Arbor Mining Co. properties.

COLFAX COUNTY

Mount Baldy district (Baldy, Elizabethtown, Therma).—Lessees of the Aztec Mines property of the Maxwell Land Grant Co., including the Aztec 50-ton amalgamation-gravity concentration mill at the head of Ute Creek, did development work in the mines from January 1 to May 3, 1934, when they began mining and milling ore; they maintained a steady output of amalgamation bullion and concentrates to the end of the year. The Montezuma mine, also owned by the Maxwell Land Grant Co., was operated intermittently during the year by lessees who treated most of the ore in a 10-ton amalgamation-concentration mill at the property; the bullion was shipped to the Denver Mint, and the concentrates and some crude ore were sold to the Golden Cycle mill at Colorado Springs, Colo. Gold bullion was produced at the Rebel Chief group by putting the ore containing muddy material through a hand washer and the fines through a rocker, where the gold was caught in riffles; some sorted high-grade ore was ground in a hand mortar. Small lots of gold ore were shipped to the Golden Cycle mill from the Red Bandana and Rio mines and from a prospect near Therma, and a 1-ton lot from another claim in the Mount Baldy district went to the El Paso smelter.

Placer gold was produced by small sluicing operations on South Ponil, Ute, and Willow Creeks, by ground sluicing in Willow Gulch, and by drift mining at the Ute Creek placers.

DONA ANA COUNTY

Organ district.—Lessees on the Bennett-Stephenson group operated the mine and 50-ton concentration mill part of 1934 and shipped silver-lead ore and concentrates containing a little gold and copper to the El Paso smelter. The other output of the Organ district consisted of small lots of silver ore from the Crested Butte and Silver Moon claims and gold-silver-copper ore from the Rich Streak group, all shipped to the El Paso smelter.

GRANT COUNTY

Burro Mountain district (Tyrone).—A lessee on the Contact group shipped 483 dry tons of oxidized gold-silver ore to the El Paso smelter. At the Shamrock group 80 tons of gold-silver ore were mined and treated in the 5-ton ball mill equipped with amalgamation plates and tables and yielded amalgamation bullion containing 23.09 fine ounces of gold and 9 ounces of silver; the table concentrates produced—2 tons—contained 3.68 ounces of gold and 8 ounces of silver. In addition, 18 tons of ore containing 32.09 ounces of gold, 59 ounces of silver, and a little copper and lead were shipped crude to the El Paso smelter. One car of smelting copper ore was shipped crude from the Burro Mountain group of the Phelps Dodge Corporation.

Central district (*Bayard, Fierro, Georgetown, Hanover, Santa Rita*).—In 1934 the Black Hawk Consolidated Mines Co. 250-ton concentrator 1 mile south of Hanover operated as a custom mill for the treatment of zinc-lead-copper-silver sulphide ore from the Ground Hog and San Jose properties of the Asarco Mining Co. near Cobre and also treated company ore of somewhat similar type. The mill feed averaged 4.98 ounces silver per ton, 2.75 percent copper (wet assay), 5.03 percent lead (wet assay), and 9.96 percent zinc. The mill was operated 344 days at a daily average of 200 tons. Part of the ore mined at the Ground Hog and San Jose properties was of direct smelting grade and was shipped crude to the El Paso smelter. The Nevada Consolidated Copper Corporation, Chino Mines division, operated its flotation mill at Hurley for 147 days (14 to 18 days a month) at an average daily rate of 6,805 tons; the mill consists of 7 units with a total capacity of 15,000 tons in 24 hours. The ore is mined from open pits at Santa Rita by electric shovels. The mines and mill were closed in October 1934 for an indefinite period. Lessees at the property of the Hanover-Bessemer Iron & Copper Co. made regular shipments of gold ore to the El Paso smelter. The Peru Mining Co. operated its 300-ton Peru mill at Deming 223 days during 1934 at an average daily rate of 298 tons on lead-free zinc sulphide ore from its Pewabic mine at Hanover. Several cars of smelting ore obtained from various mines and dumps were shipped from Fierro. The St. Helena & Eighty-Eight Mining Co. made a small output of gold bullion from its cyanide plant at Central.

The McGraw Ranch placer on San Domingo Creek, operated by the Consolidated Placers, Inc., during the summer and by the Cibola Placer Co. from October 1 to December 1, produced 105.68 ounces of placer gold, 0.846 fine in gold and 0.147 fine in silver, from 5,066 cubic yards of material handled. The deposit is worked by an electric power shovel delivering gravel to a field trommel which discards plus 2½-inch oversize, the undersize being hauled by trucks to a treating plant. The equipment of the plant consists of belt conveyor, trommel, jig, concentrating tables, Dorr classifier, settling tanks for reclaiming water, and belt tailings stacker. A little placer gold was also produced from various small sluicing operations in the Central district.

Eureka district (*Hachita*) (*see also Hidalgo County*).—A lessee on the King "400" mine shipped 10 tons of silver ore containing a little copper and lead to the El Paso smelter in 1934.

Gold Hill district (*see also Hidalgo County*).—The Indian Springs Mining Co. shipped 30 tons of gold ore in 1934 from its Indian Springs-God's Tenth group to the El Paso smelter. The other output from the Grant County section of the Gold Hill district was smelting ore shipped from the Virginia mine and Standard-Reservation group.

Pinos Altos district.—The Hazard mine 1½ miles northeast of Pinos Altos, at which development work was begun December 1, 1933, was operated continuously in 1934 and produced 1,142 tons of oxidized gold-silver-lead-copper ore which was shipped to the El Paso smelter. O. B. Metcalfe operated several mines in the Pinos Altos district and shipped mine and dump ore to the El Paso smelter throughout the year; his shipments included ore from the Baltimore, Geo. Shafer group, Houston Thomas, Langston, Mackinaw, Silver Bell, Silver Hill, and other mines. Producing lode mines worked by other operators included the Florence C, Kept Woman, Lone, Silver King, and Three Brothers.

Placer gold was purchased in small lots by dealers in Silver City and Pinos Altos from many individuals engaged in panning, rocking, and sluicing near Pinos Altos. Some of the placer miners shipped their gold direct to the Denver Mint. The Thomas J. Crowe Corporation, operating a small placer machine doing test work at the Rathbun placer on Bear Creek, shipped bullion to the Denver Mint and to the Selby (Calif.) smelter.

Steeple Rock district (22 miles northeast of Duncan, Ariz., by road).—At the East Camp group, in the Steeple Rock district, surface buildings and a road to the mine were constructed in 1934 and mine equipment was installed. The development in 1934 was on the Davenport claim, opened by a 300-foot shaft and drifts, and on the McDonald claim, opened by a 380-foot adit and upraises. Production of ore was started March 1 and continued throughout the year. The output was chiefly from the McDonald and totaled 1,573 tons of ore containing 412.97 ounces of gold, 20,630 ounces of silver, and 1,700 pounds of copper; all the ore was shipped crude to the El Paso smelter. The owner reported that the ore was being tested and plans were being made to construct a cyanide plant at the mine. A small tonnage of ore of a type similar to that found in the East Camp group was shipped from another mine in the district.

White Signal district.—One car of silver ore taken from the dump of the Tioga-Marion claims was shipped in 1934 to the El Paso smelter.

HIDALGO COUNTY

Eureka district (Hachita) (see also Grant County).—In 1934 the Barney group produced 454 tons of ore containing 266.95 ounces of gold, 314 ounces of silver, 367 pounds of copper, and 100 pounds of lead; the ore was shipped crude to smelters. The Hidalgo Gold Mines Co. erected surface buildings, installed mining equipment, and did general exploratory and development work throughout the year at its Hardscrabble group; the company shipped 41 tons of ore containing 73.20 ounces of gold, 10 ounces of silver, and 344 pounds of copper to the El Paso smelter. The "Copper Dick" and Ida May mines each produced 1 car of copper ore, and two other properties in the Eureka district (Hidalgo County) made small shipments—one of gold ore and the other of silver ore.

Gold Hill district (see also Grant County).—Floyd & Aden, operating the Oro Grande mine, were the only shippers of ore from the Hidalgo County section of the Gold Hill district in 1934.

Lordsburg district (including Pyramid and Virginia or Shakespeare districts).—From the Faith, Hope, and Charity group 201 tons (dry weight) of ore containing 87.33 ounces of gold, 534 ounces of silver, 1,397 pounds of copper, and 10,282 pounds of lead were shipped to the El Paso smelter in 1934. Copper-silver-gold ore from the Misers Chest and siliceous copper-silver-gold ore from the Bonney mine were shipped to smelters. The remaining output of the Lordsburg district was made up of small lots of ore shipped to the El Paso

(Tex.) and Douglas (Ariz.) smelters from miscellaneous individual operations at various mines and prospects.

San Simon district (*Steins*).—The "66" mine was operated continuously in 1934 after June 1 and produced 146 tons of ore averaging 0.162 ounce gold and 43 ounces silver per ton. The Life Insurance Development Co. shipped 54 tons of silver ore to the El Paso smelter.

LINCOLN COUNTY

Gallinas Mountains or Red Cloud district.—One car of lead-copper-silver ore was shipped by a lessee on the Deadwood-Red Cloud mine to the El Paso smelter in 1934.

Jicarilla district.—The metal output of the Jicarilla district in 1934 comprised small lots of placer gold produced in the Jicarilla Mountains southeast of Ancho by individuals and prospectors who sold most of the gold to merchants at Ancho and Carrizozo. The deposits made at the Denver Mint by the purchaser of the largest quantity (123 ounces) showed an average fineness of 0.943 in gold and 0.051 in silver.

Nogal district.—Since 1932 the Helen Rae mine has been a steady producer of gold-silver bullion from small-scale mining and milling operations, and in 1934 small shipments of bullion were made to the Denver Mint each month except May and June. A jaw crusher and small Huntington mill are used in crushing and grinding the ore before amalgamation. A small lot of silver ore was shipped from one other property during the year to the El Paso smelter.

Placers in the Nogal district, principally the Duggar, Wixon, and others in Dry Gulch, yielded bullion averaging 0.726 fine in gold and 0.270 fine in silver.

White Oaks district.—The El Avidor Gold Mining Co. shipped gold ore in 1934 from the Little Nell and Smuggler mines to the El Paso smelter. At the South Homestake mill, which burned in 1934, a clean-up of ashes yielded 10 ounces of gold and 1 ounce of silver. At the Little Mack mine ore was treated by amalgamation and yielded gold bullion, and 1 ton of high-grade gold ore was shipped to the El Paso smelter. A small lot of gold bullion recovered from a prospect in the White Oaks district was sold to the Denver Mint.

Placer gold was produced in White Oaks Gulch by hand rockers and sluicing.

LUNA COUNTY

Deming.—At Wemple near Deming is the 300-ton Peru selective flotation mill; it was operated 223 days in 1934 at an average daily rate of 298 tons on lead-free zinc sulphide ore from the Peru Mining Co. Pewabic mine at Hanover, Grant County.

Florida Mountains district.—One car of lead-silver ore containing a little copper was shipped in 1934 from the Chavez property to the El Paso smelter.

Tres Hermanas district (*Columbus*).—A small lot of silver ore and 1 car of lead-silver ore were shipped from the Tres Hermanas district to the El Paso smelter in 1934.

OTERO COUNTY

Orogrande district.—At the Center placer 2½ miles northeast of Orogrande a two-way dry washer run by a small gasoline engine was operated 3 months in 1934; the operator reported that water had to be hauled to the claim in barrels and that very little sluicing was done. A special placer machine was operated at the Little Joe placer, and small sluicing operations were carried on at several other placers in the Orogrande district.

At the Flying Eagle lode claim the owner reported the mining, during development work in 1934, of 340 tons of ore assaying 0.10 ounce gold and 5 ounces silver to the ton and 42 percent lead; the ore was not sold during the year.

RIO ARRIBA COUNTY

Headstone district.—Sluicing operations at the Lily placer on Hopewell Creek yielded 10.81 fine ounces of gold and 1 ounce of silver in 1934. Two other placers in the Headstone district each produced a little gold.

A 2-ton test lot of ore was shipped to the Golden Cycle mill at Colorado Springs, Colo., from the Rainbow No. 1 claim, but the return in recovered metals was small and is not included in the figures for district output.

SANDOVAL COUNTY

Cochiti (Bland) district.—A lessee who has been operating the Crown Point group since 1932 continued shipments of gold-silver ore to the El Paso smelter. The ore shipped in 1934 was extracted from the Crown Point and Iron King claims.

SAN MIGUEL COUNTY

Willow Creek district (Terrero).—Operations were continuous at the Pecos mine of the American Metal Co. on Willow Creek—the only producing mine in San Miguel County in 1934—in its eighth year of production. The mill is in Alamitos Canyon 6 miles by road from Glorieta station and 4 miles by railroad spur from Fox station on the Atchison, Topeka & Santa Fe Railway and is connected with the mine by a 12-mile aerial tram; it treated an average of 550 tons daily during the year.

The heads of ore into the mill in 1934 averaged 0.105 ounce gold and 3.40 ounces silver per ton, 0.62 percent copper (wet assay), 4.17 percent lead (wet assay), 11.79 percent zinc, and 13.73 percent iron. The yield from 200,839 dry tons of ore treated in 1934 was 37,005 tons of zinc concentrates—averaging 0.046 ounce gold and 2.98 ounces silver per ton, 0.75 percent copper (wet assay), 1.19 percent lead (wet assay), 54.85 percent zinc, and 8.36 percent iron—and 16,988 tons of lead-copper concentrates—averaging 0.82 ounce gold and 25.51 ounces silver per ton, 3.68 percent copper (wet assay), 40.18 percent lead (wet assay), 9.75 percent zinc, and 13.16 percent iron.

SANTA FE COUNTY

Los Cerrillos district.—One car of gold-silver-copper ore from the Benton mine and 1 car of lead-silver ore from one other mine in the Los Cerrillos district were shipped in 1934 to the El Paso smelter. In addition, amalgamation bullion produced at the Benton mine was sold to the Denver Mint.

Merchants at Cerrillos purchased small lots of gold produced from panning, sluicing, and dry-washing operations in the district.

San Pedro or New Placers district.—Lessees driving a tunnel in the La Santa Fe mine extracted 13 tons of gold ore from a small quartz vein and had it milled in 1934 as custom ore in the 6-foot Huntington mill operated by Joe Stewart on his ranch; amalgamation bullion recovered yielded 17.62 fine ounces of gold and 2 fine ounces of silver. Small lots of gold bullion produced from the Delgado and San Pedro mines were sold to the Denver Mint.

Small sluicing and dry-washing operations yielded placer gold which was marketed through jewelers and mercantile establishments or sent direct to the Denver Mint.

SIERRA COUNTY

Apache, Cuchillo Negro district (Chloride).—At the St. Cloud-Colossal group the Nina Maria Mining Co. milled 100 tons of dump ore and 35 tons of ore from the mine in a mill at the property, rebuilt during 1934 and operated for a period in June and July but closed July 31. The crushing was done by a 20-ton ball mill. The Callow flotation equipment has a capacity of 75 tons, and the product was 2 tons of silver-copper concentrates containing a very small quantity of gold and lead. A small lot of copper-silver ore was shipped by another operator from the St. Cloud mine dump to the El Paso smelter. Test lots of less than a carload were shipped to the El Paso smelter from two other properties, one of which was the Great Southwest-U.S. Treasury group.

Kingston district.—Two small lots of silver ore were shipped from Kingston to the El Paso smelter in 1934.

Lake Valley district.—The Lake Valley mine was the only producer of metals in the Lake Valley district in 1934.

Las Animas (Hillsboro) district.—The preceding table by districts shows that there are more producing lode mines in the Hillsboro district than in any other district in the State, but it also shows that their aggregate output of metals is comparatively small. This condition is explained by the fact that the operators of only two mines—the El Oro and Snake-Opportunity group—shipped more than 1 car of ore or concentrates out of the district in 1934. Small tonnages of ore produced at undeveloped mines and prospects or taken from dumps were concentrated at a small custom mill at Hillsboro, and the concentrates produced were sold chiefly to ore buyers at Douglas, Ariz., who resold them to the smelter. Small lots of smelting ore were shipped to the El Paso smelter, and bullion produced in an arrastre treating ore from a small vein in the Curtis mine was sold to the Denver Mint.

The John I. Hallett Construction Co., operating since January 1, 1934, the Animas Consolidated and Slease Leases (a consolidation of the old Gold Dust and other placers, totaling 1,200 acres), was the largest producer of placer gold in the Hillsboro district and in the State in 1934. Equipment consisted of 1 drag-line excavator, with a capacity of 700 cubic yards in 24 hours, and a Coulter-Ainlay portable recovery plant, with 4 Ainlay 36-inch bowls, using gasoline engines for power; a new Northwest drag line was added on January 1, 1935. Operations were continuous during 1934 except for a period from June 2 to August 4, and the company handled 70,000 cubic yards of material and recovered 1,110 fine ounces of gold. Considerable time was spent in prospecting. Testing was done at the Wakely placer which comprises 640 acres of school lands, and the installation of machinery was begun for large-scale operations in 1935. Small sluicing and dry-washing operations at other placers yielded small lots of placer gold.

Pittsburg district.—Placer gold produced at the Shandon placers was shipped to the Denver Mint intermittently during 1934. Some output was made early in the year from operation of the drag line and Ainlay bowls installed in 1933; after July another company, the Consolidated Mines, Inc., operated the property irregularly by hydraulicking. Many small sluicing and dry-washing operations were conducted by individuals and prospectors.

SOCORRO COUNTY

Good Fortune district.—One car of copper ore mined by hand drills and picks at the Bella Vista claim was shipped in 1934 to the El Paso smelter.

Magdalena district.—Crude ore was shipped in 1934 to smelters from the Kelly, Morning Star, and two other mines in the Magdalena district.

Mockingbird district.—A prospector shipped 4 tons of lead ore in 1934 to the El Paso smelter from a claim at Mockingbird Gap which he abandoned after driving a 25-foot tunnel.

Rosedale district.—From the Rosedale mine the Black Bear Mining Co. shipped 58 tons of gold-silver ore to the El Paso smelter in 1934. The company retimbered the old shaft, did development work in the mine, and began to recondition the mill, but it was succeeded by the Rosedale Mines which early in 1935 installed new equipment, including Hadsel mill, classifier, copper plates for amalgamating coarse gold, cyanide tanks, and Oliver filter. The Rosedale Mines reported that it was scheduled to start production by May 1, 1935.

San Mateo Mountains district.—Gold-silver ore was shipped in 1934 from San Marcial to the El Paso smelter by the Springtime Mining Co. and T. B. Everhart, both operating newly developed claims in the San Mateo Mountains district.

Silver Hills district.—In 1934 the Open Cut Mines continued small test runs of its 25-ton flotation mill built in 1933 but discontinued the flotation process and replaced it by a 20-mesh slot feed direct to a sand table and tailings launder lined with a cotton blanket. The product in 1934 was 243 pounds of gold concentrates containing 2.30 ounces of gold and 2 ounces of silver and was sold to the Golden Cycle mill at Colorado Springs, Colo.

TAOS COUNTY

Red River district.—A test lot of gold ore was shipped from the Denmark claim to the Golden Cycle mill in 1934. The Molybdenum Corporation of America continued operations at the Phyllis group on Sulphur Creek; its 40-ton (per 24 hours) flotation mill at the junction of Sulphur Creek and Red River above Questa was not run at capacity.

Rio Grande River district.—At the Armstrong placer claims on the Rio Grande River about 3 miles northwest of San Cristobal the owner, using a sluice box with rubber mats added at the end to catch flake gold, recovered 2.51 crude ounces of placer gold in 1934 with a fineness in gold of 0.781 and in silver of 0.210.

A prospector at the Black Hawk No. 1 claim found a small vein terminating in a pocket from which he took 250 pounds of ore yielding 7.65 crude ounces of bullion 0.8355 fine in gold and 0.1615 fine in silver.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN OREGON

(MINE REPORT)

By F. W. Horton and H. M. Gaylord

SUMMARY OUTLINE

The output of gold, silver, copper, lead, and zinc from Oregon ores and gravels in 1934, in terms of recovered metals, was 33,711.59 fine ounces of gold, 46,560 fine ounces of silver, 38,373 pounds of copper, 41,603 pounds of lead, and 73,184 pounds of zinc. The value of the metal output was $1,216,075 in 1934—the largest since 1920 and 131 percent greater than in 1933 when 20,239.66 ounces of gold, 20,760 ounces of silver, 11,453 pounds of copper, 9,379 pounds of lead, and 12,290 pounds of zinc were produced. The value of the gold in 1934 represented 97 percent of the total value of the five metals. There were 95 lode mines and prospects and 332 placers producing in 1934 compared with 111 lode mines and prospects and 292 placers in 1933. Fourteen lode mines and 12 placers produced over 100 ounces of gold each in 1934, and of these 2 lode mines and 4 placers yielded over 1,000 ounces each.

The quantity of ore, old tailings, and old mill cleanings milled and shipped or shipped crude was 62,145 tons in 1934, or nearly 5½ times that in 1933; its average yield per ton was 0.185 ounce of gold and 0.692 ounce of silver.

Baker County, with a metal production in 1934 valued at $427,269, was the largest contributor to the value of the State metal output and supplied 35 percent of the total; Jackson and Grant Counties followed, with 24 and 18 percent, respectively.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly United States Government prices.[1] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

[1] The Treasury from Feb. 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of Jan. 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to Jan. 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, copper, lead, and zinc in Oregon, 1930–34, in terms of recovered metals

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1930	47	143	8,994	14,401.34	$297,702	9,000	$3,465
1931	57	139	7,092	15,350.10	317,315	7,254	2,104
1932	99	169	5,195	19,861.21	410,568	8,616	2,430
1933	111	292	11,557	20,239.66	[1] 517,326	20,760	7,266
1934	95	332	62,145	33,711.59	1,178,220	46,560	30,099

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1930	176,300	$22,919	9,113	$456	12,528	$601	$325,143
1931	1,700	155	3,497	129	---------	---------	319,703
1932	32,199	2,029	7,917	238	12,061	362	415,627
1933	11,453	733	9,379	347	12,290	516	[1] 526,188
1934	38,373	3,070	41,603	1,539	73,184	3,147	1,216,075

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold.—The production of gold in Oregon in 1934 was 33,711.59 fine ounces, an increase of 66.6 percent over 1933. The yield from lode mines increased 110 percent and that from placers 50.4 percent. Lode and placer mines furnished 34 and 66 percent, respectively, of the total gold in 1934 compared with 27 and 73 percent, respectively, in 1933.

In 1934 Baker County was as usual by far the largest producer of lode gold, supplying 60 percent of the State total lode gold; the other principal lode-gold producing counties were Jackson, Josephine, Lane, and Grant, in the order named. These five counties produced 95 percent of the total lode gold. Dry gold ore, old tailings, and old mill cleanings treated amounted to 61,255 tons and yielded 11,450.94 ounces of gold or 99.8 percent of the total lode gold; the rest, 20.74 ounces, was derived largely from gold-silver and silver ores. Of the total lode gold recovered 6,266.60 ounces (54.6 percent) were from smelting flotation concentrates, 3,476.63 ounces (30.3 percent) from amalgamation of ore and old tailings, 1,571.05 ounces (13.7 percent) from smelting ore and old mill cleanings, and 157.40 ounces (1.4 percent) from smelting table concentrates.

Placer mines in Oregon in 1934 yielded 22,239.91 fine ounces of gold—practically twice the output of lode gold. The placer workings, mostly small and generally operated only for a few months when enough water was available for washing, numbered 332 compared with 292 in 1933. Jackson County was again the largest producer of placer gold and furnished 29.8 percent of the State placer total in 1934; Grant, Baker, and Josephine Counties followed closely, with 24.5, 20.5, and 19.5 percent, respectively. Dredges produced 9,254.47 ounces of gold (41.6 percent of the placer total) compared with 4,736.17 ounces in 1933 when dredging was badly handicapped by lack of water. Four dredges were operated in 1934, one by each of the following companies: Pioneer Gold Dredging Co., Baker County; Monarch Gold Dredging Co. (old Empire dredge) and Timms Gold Dredging Co., both in Grant County; and Rogue River Gold Co., Jackson County. These four dredges handled 1,912,302 cubic yards of gravel and made an average recovery of 0.0048 ounce of fine gold per cubic yard. Hydraulic mining produced 2,214.98 ounces of gold, drift mining 1,038.73 ounces, and other placer-mining methods (dragline and power-shovel operations, ground and hand sluicing, rocking, panning, etc.) 9,731.73 ounces, or 10.0, 4.7, and 43.7 percent, respectively, of the total placer gold.

Production by itinerant miners formed an important part of the total placer output in 1934. The number of such miners increased compared with 1933, and purchases by bullion buyers, to whom practically their entire production was sold, aggregated 6,748 fine ounces, nearly twice those in 1933 and more than 30 percent of the State output of placer gold in 1934. Of this total Jackson County supplied 2,821 ounces; Josephine County, 2,376 ounces; Baker County, 549 ounces; Grant County, 439 ounces; Douglas County, 315 ounces; and Coos, Curry, Lane, Lincoln, Linn, and Malheur Counties, the rest (248 ounces). Analysis of 1,506 purchases by bullion buyers, selected at random, shows that purchases from itinerant miners averaged approximately one-half ounce of gold each. The total (6,748 ounces) does not represent all the gold sold to banks and bullion buyers in 1934, as considerable quantities were bought from established producers.

Silver.—The output of silver in Oregon in 1934 was 46,560 ounces valued at $30,099 compared with 20,760 ounces valued at $7,266 in 1933, an increase of 124 percent in quantity and 314 percent in value. Baker County contributed 81.3 percent of the total in 1934, and over half of its output was made by Cornucopia Gold Mines, Inc., at Cornucopia; the counties ranking next were Jackson and Grant, with 7.0 and 4.5 percent, respectively. Of the total silver, 58.1 percent came from dry gold ore, 32.9 percent from dry gold-silver and silver ores, and 1.3 percent from lead and lead-zinc ores; the rest (7.7 percent) was recovered from placer bullion.

Copper.—No copper ore was mined in Oregon in 1934, and the 38,373 pounds of copper produced were derived wholly as a byproduct from other ores as follows: 26,613 pounds from gold ore, 9,900 pounds from gold-silver and silver ores, and 1,860 pounds from lead and lead-zinc ores; the copper was valued at $3,070. In 1933 the copper output was 11,453 pounds valued at $733.

Lead.—The production of lead from Oregon ores in 1934 was 41,603 pounds valued at $1,539 compared with 9,379 pounds valued at $347 in 1933. Of the total in 1934, 28,839 pounds were smelted from concentrates and 12,764 pounds from ore. Marion County was the largest producer of lead, followed by Lane, Grant, Jackson, and Baker Counties, named in order of output.

Zinc.—Zinc produced from Oregon ore in 1934 totaled 73,184 pounds valued at $3,147 compared with 12,290 pounds valued at $516 in 1933. The entire output was derived from lead-zinc ore mined in Marion County.

MINE PRODUCTION BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in Oregon in 1934, by counties, in terms of recovered metals

County	Gold						Silver (lode and placer)	
	Lode		Placer		Total			
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Baker	6,894.66	$240,968	4,570.24	$159,730	11,464.90	$400,698	37,837	$24,460
Coos and Marion	152.09	5,316	124.32	4,345	276.41	9,661	612	396
Curry	14.17	495	365.83	12,786	380.00	13,281	51	33
Douglas	199.48	6,972	419.74	14,670	619.22	21,642	276	178
Gilliam			5.86	205	5.86	205	1	1
Grant	740.80	25,891	5,450.02	190,478	6,190.82	216,369	2,103	1,360
Harney			8.10	283	8.10	283	1	1
Jackson	1,526.95	53,367	6,626.97	231,613	8,153.92	284,980	3,279	2,120
Josephine	896.59	31,336	4,345.45	151,873	5,242.04	183,209	1,529	988
Lake	3.50	122			3.50	122	9	6
Lane	875.65	30,604	34.00	1,188	909.65	31,792	655	423
Lincoln			74.63	2,608	74.63	2,608	14	9
Linn			20.91	731	20.91	731	6	4
Malheur	167.79	5,864	99.82	3,489	267.61	9,353	174	112
Morrow			1.41	49	1.41	49		
Umatilla			7.56	264	7.56	264		
Union			3.00	105	3.00	105		
Wheeler			53.01	1,853	53.01	1,853	8	5
Undistributed [1]			29.04	1,015	29.04	1,015	5	3
	11,471.68	400,935	22,239.91	777,285	33,711.59	1,178,220	46,560	30,099
Total, 1933	5,456.90	[2] 139,478	14,782.76	[2] 377,848	20,239.66	[2] 517,326	20,760	7,266

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Baker	26,150	$2,092	517	$19			$427,269
Coos and Marion	1,860	149	28,062	1,038	73,184	$3,147	14,391
Curry							13,314
Douglas	530	42					21,862
Gilliam							206
Grant	2,838	227	689	25			217,981
Harney							284
Jackson	2,213	177	535	20			287,297
Josephine	932	75					184,272
Lake							128
Lane	3,850	308	11,800	437			32,960
Lincoln							2,617
Linn							735
Malheur							9,465
Morrow							49
Umatilla							264
Union							105
Wheeler							1,858
Undistributed [1]							1,018
	38,373	3,070	41,603	1,539	73,184	3,147	1,216,075
Total, 1933	11,453	733	9,379	347	12,290	516	[2] 526,188

[1] Gold and silver that could not be allocated.
[2] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Ore, old tailings, etc., sold or treated and lode mines producing in Oregon, 1933–34, by counties

County	Ore, old tailings, etc. (short tons)		Lode mines producing	
	1933	1934	1933	1934
Baker	5,842	37,376	28	25
Coos		1		1
Crook	34		1	
Curry	7	4	3	2
Douglas	1,242	862	6	3
Grant	887	1,828	16	18
Harney	55		2	
Jackson	2,581	12,789	30	21
Josephine	708	7,851	18	16
Lake		1		1
Lane	123	581	2	3
Linn	12		1	
Malheur	9	551	2	3
Marion	57	301	2	2
	11,557	62,145	111	95

MINING INDUSTRY

As the mining industry in Oregon is practically synonymous with gold mining, the higher price of gold in 1934 stimulated it greatly. Although considerable time is required to prepare for increasing the yield of operating properties, to rehabilitate old mines, and to bring prospects to the producing stage the effects of the advance in the average gold price from $25.56 an ounce in 1933 to $34.95 an ounce in 1934 were evidenced by increases over 1933 of 66.6 and 127.8 percent, respectively, in quantity and value of the gold produced and 438 percent in tonnage of ore, old tailings, etc., treated. In Eastern Oregon there was notable expansion of placer mining due to drag-line operations along Pine Creek in northern Baker County and the Powder River near Sumpter (also in Baker County) and to the operation of two dredges in Grant County. In Western Oregon dredge-gold production dropped due to lack of water, but small placer operations along the Rogue, Applegate, and Illinois River drainages increased and resulted in maintaining the output. Lode mining for metals other than gold was not active, and only a small output of base metals was made.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in Oregon in 1934, with content in terms of recovered metals

Source	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold ore	[1] 61,255	11,450.94	27,074	26,613	13,413	
Dry gold-silver and silver ores [2]	587	16.43	15,297	9,900		
Lead and lead-zinc ores [2]	303	4.31	612	1,860	28,190	73,184
Total, lode mines	62,145	11,471.68	42,983	38,373	41,603	73,184
Total, placers		22,239.91	3,577			
	62,145	33,711.59	46,560	38,373	41,603	73,184
Total, 1933	11,557	20,239.66	20,760	11,453	9,379	12,290

[1] Includes 16,666 tons of old tailings concentrated, 118 tons of old mill cleanings smelted, and 50 tons of old tailings amalgamated.
[2] Combined to avoid disclosing individual outputs.

Value of metals from ore, old tailings, etc., sold or treated in Oregon in 1934, by classes of ore

Class	Ore, old tailings, etc. short) tons)	Gold	Silver	Copper	Lead	Zinc	Total value
Dry gold ore	[1] 61,255	$400,210	$17,502	$2,129	$496		$420,337
Dry gold-silver and silver ores[2]	587	574	9,889	792			11,255
Lead and lead-zinc ores [2]	303	151	396	149	1,043	$3,147	4,886
	62,145	400,935	27,787	3,070	1,539	3,147	436,478
Total, 1933	11,557	[3] 139,478	6,508	733	347	516	[3] 147,582

[1] Includes 16,666 tons of old tailings concentrated, 118 tons of old mill cleanings smelted, and 50 tons of old tailings amalgamated.
[2] Combined to avoid disclosing individual outputs.
[3] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Ore, old tailings, etc., sold or treated in Oregon in 1934, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Baker	[1] 36,789	6,877.81	21,749	16,250	389	
Coos and Curry	5	163.92	17			
Douglas	862	199.48	226	530		
Grant	1,826	739.25	1,168	2,838	689	
Jackson	12,789	1,526.95	2,172	2,213	535	
Josephine	[2] 7,851	896.59	933	932		
Lake	1	3.50	9			
Lane	581	875.65	645	3,850	11,800	
Malheur	551	167.79	155			
	61,255	11,450.94	27,074	26,613	13,413	
Total, 1933	11,293	5,397.21	11,525	6,316	4,216	

DRY GOLD-SILVER AND SILVER ORES [3]

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Baker and Grant	587	16.43	15,297	9,900		
	587	16.43	15,297	9,900		
Total, 1933	[4] 215	11.20	6,929	4,735		

LEAD AND LEAD-ZINC ORES [3]

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Baker and Marion	303	4.31	612	1,860	28,190	73,184
	303	4.31	612	1,860	28,190	73,184
Total, 1933	49	48.49	140	402	5,163	12,290

[1] Includes 10,652 tons of old tailings concentrated and 118 tons of old mill cleanings smelted.
[2] Includes 6,014 tons of old tailings concentrated and 50 tons amalgamated.
[3] Combined to avoid disclosing individual outputs.
[4] Silver ore; no gold-silver ore produced in 1933.

METALLURGIC INDUSTRY

Ore, including old tailings and a few tons of old mill cleanings, from Oregon mines treated in 1934 amounted to 62,145 tons, of which 8,456 tons were amalgamated, 35,206 tons of ore and 16,666 tons of old tailings concentrated, and 1,817 tons sent direct to smelters; no material was reported treated by cyanidation. Of the total concentrates produced 1,199 tons (96.8 percent) were made by flotation and only 40 tons by tabling, illustrating the great extent to which flotation has supplanted tabling as a method of concentration in Oregon mills. The 1,105 tons of dry gold concentrates produced from ore and old tailings in 1934 had an average gross metal content per ton of 5.62 ounces of gold, 20.21 ounces of silver, 18.1 pounds of copper, and 1.3 pounds of lead. The 1,109 tons of dry gold ore smelted directly had an average gross metal content per ton of 1.29 ounces of gold, 2.88 ounces of silver, 6.2 pounds of copper, and 12.4 pounds of lead.

Mine production of metals in Oregon in 1934, by methods of recovery

Method of recovery	Material treated	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Ore and old tailings amalgamated	8,456	3,476.63	947	--------	--------	--------
Ore and old mill cleanings smelted	1,817	1,571.05	18,761	15,018	12,764	--------
Concentrates smelted:						
Flotation	1,199	6,266.60	22,707	23,115	28,839	73,184
Table	40	157.40	568	240	--------	--------
Total, lode mines	---------	11,471.68	42,983	38,373	41,603	73,184
Total, placers	---------	22,239.91	3,577	--------	--------	--------
	---------	33,711.59	46,560	38,373	41,603	73,184
Total, 1933	---------	20,239.66	20,760	11,453	9,379	12,290

Mine production of metals from gold and silver (amalgamation) mills in Oregon in 1934, by counties, in terms of recovered metals

County	Ore and old tailings treated		Recovered in bullion		Concentrates and recovered metal				
	Ore	Old tailings	Gold	Silver	Concentrates produced	Gold	Silver	Copper	Lead
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Baker	2,408	--------	1,223.76	422	107	346.07	479	--------	--------
Coos, Curry, Douglas, and Lane	280	--------	279.30	50	--------	--------	--------	--------	--------
Grant	1,269	--------	358.59	83	13	27.88	32	240	--------
Jackson	2,341	--------	686.01	218	13	78.55	105	--------	--------
Josephine	1,558	50	764.98	132	5	24.41	3	--------	--------
Malheur	550	--------	163.99	42	--------	--------	--------	--------	--------
	8,406	50	3,476.63	947	138	476.91	619	240	--------
Total, 1933	5,097	--------	2,389.88	525	74	196.08	1,011	1,110	4,216

Mine production of metals from concentrating mills in Oregon in 1934, by counties, in terms of recovered metals

County	Ore and old tailings treated		Concentrates and recovered metal					
	Ore	Old tailings	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Short tons*	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Baker and Grant	23,787	10,652	681	5,078.25	20,524	18,615	863	--------
Douglas, Jackson, Josephine, and Marion	11,419	6,014	420	868.84	2,132	4,500	27,976	73,184
	35,206	16,666	1,101	5,947.09	22,656	23,115	28,839	73,184
Total, 1933	4,597	--------	134	905.48	3,027	4,159	4,925	12,290

Gross metal content of Oregon concentrates produced in 1934, by classes of concentrates

Class of concentrates	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold	1,105	6,209.03	22,327	20,011	1,446	----------
Copper	32	213.07	371	2,212	----------	----------
Lead	26	1.70	427	1,101	25,053	----------
Zinc	76	.20	150	1,282	4,641	81,316
	1,239	6,424.00	23,275	24,606	31,140	81,316
Total, 1933	208	1,101.56	4,038	5,565	11,551	13,809

Mine production of metals from Oregon concentrates in 1934, in terms of recovered metals

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Baker	732	5,118.86	20,018	16,250	174	----------
Douglas and Marion	125	133.33	765	2,287	27,976	73,184
Grant	69	333.34	1,017	2,605	689	----------
Jackson	301	797.04	1,456	2,213	----------	----------
Josephine	12	41.43	19	----------	----------	----------
	1,239	6,424.00	23,275	23,355	28,839	73,184
Total, 1933	208	1,101.56	4,038	5,269	9,141	12,290

BY CLASSES OF CONCENTRATES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
Dry gold	1,105	6,209.03	22,327	19,353	863	----------
Copper	32	213.07	371	2,142	----------	----------
Lead	26	1.70	427	770	23,800	----------
Zinc	76	.20	150	1,090	4,176	73,184
	1,239	6,424.00	23,275	23,355	28,839	73,184

Gross metal content of Oregon crude ore shipped to smelters in 1934, by classes of ore

Class of ore	Ore (dry weight)	Gross metal content			
		Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Dry gold	1,109	1,435.60	3,190	6,825	13,781
Dry gold-silver and silver [1]	587	16.43	15,297	10,102	----------
Lead	3	2.41	35	----------	357
	1,699	1,454.44	18,522	16,927	14,138
Total, 1933	1,845	1,950.87	13,971	6,385	397

[1] Combined to avoid disclosing individual outputs.

Mine production of metals from Oregon crude ore shipped to smelters in 1934, in terms of recovered metals

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Baker	951	435.43	16,361	9,900	343
Douglas	2	18.91	33	103	
Grant	19	48.87	106	233	
Jackson	139	43.90	498		535
Josephine and Lane	585	899.59	1,399	4,782	11,800
Lake	1	3.50	9		
Malheur	1	3.80	113		
Marion	1	.44	3		86
	1,699	1,454.44	18,522	15,018	12,764
Total, 1933	1,845	1,950.87	13,971	6,184	238

BY CLASSES OF ORE

	Ore	Gold	Silver	Copper	Lead
Dry gold	1,109	1,435.60	3,190	5,118	12,550
Dry gold-silver and silver [1]	587	16.43	15,297	9,900	
Lead	3	2.41	35		214
	1,699	1,454.44	18,522	15,018	12,764

[1] Combined to avoid disclosing individual outputs.

REVIEW BY COUNTIES AND DISTRICTS

Mine production of gold, silver, copper, lead, and zinc in Oregon in 1934, by counties and districts, in terms of recovered metals [1]

County and district [1]	Mines producing		Ore, old tailings, etc.	Gold			Silver (lode and placer) [2]	Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total					
Baker County:			*Short tons*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Baker	7	6	30	77.09	68.33	145.42	593		243		$5,474
Bridgeport		1			195.75	195.75	25				6,857
Bull Run	1	1	3	2.00	8.64	10.64	3				374
Cable Cove	1		9	14.89		14.89	66				563
Connor Creek	1	15	3	7.68	261.09	268.77	104				9,461
Cornucopia	1	5	33,884	4,771.69	939.33	5,711.02	19,708	16,250	174		213,647
Cracker Creek	1	1	132	82.58	7.00	89.58	519				3,467
Eagle Creek	2	2	16	6.68	14.84	21.52	6				756
Greenhorn [3]	2	6	181	159.19	154.77	313.96	80				11,025
Mormon Basin [4]	1	10	2,000	1,222.04	1,765.68	2,987.72	604				104,811
Pine Creek		4			52.10	52.10	13				1,829
Rock Creek	2		94	119.48		119.48	107		100		4,249
Sparta	1	2	14	9.54	9.58	19.12	34				690
Sumpter	2	4	916	361.14	688.67	1,049.81	15,882	9,900			47,750
Weatherby	3	7	94	60.66	42.02	102.68	24				3,605
Undistributed [5]					289.38	289.38	58				10,151
Coos County:											
Coos Bay		5			18.26	18.26	5				641
Johnson Creek		11			42.40	42.40	6				1,486
Randolph		2			56.34	56.34	6				1,973
Curry County:											
Agness		(6)			11.60	11.60	3				407
Chetco	2	2	4	14.17	26.44	40.61	5				1,422
China Diggings		5			9.80	9.80	1				344
Gold Beach		5			68.90	68.90	8				2,413
Port Orford		(6)			8.98	8.98	2				315
Sixes		5			240.11	240.11	32				8,413
Douglas County:											
Canyonville		1			2.86	2.86					100
Cow Creek		9			189.44	189.44	22				6,635
Drew Creek		1			2.00	2.00					70
Green Mountain		1			55.74	55.74	8				1,953
Nugget	1		700	98.70		98.70	139	293			3,563
Olalla		(6)			10.32	10.32					361
Riddle	1	4	50	49.14	131.11	180.25	19				6,312
Roseburg		1			25.22	25.22	6				885
Gilliam County: Blalock Island		1			5.86	5.86	1				206
Grant County:											
Canyon	4	12	56	91.05	1,852.84	1,943.89	300				68,133
Granite	5	14	299	131.61	216.30	347.91	711	223	689		12,662
Greenhorn [3]	2	4	20	22.73	85.79	108.52	32				3,814
Quartzburg	5	(6)	1,151	276.72	18.86	295.58	136	473			10,457

Susanville	2	3	302	218.69	3,064.00	3,282.69	879	2,142			115,469
Undistributed [5]					212.23	212.23	45				7,446
Harney County: Harney		1			8.10	8.10	1				284
Jackson County:											
Ashland	3	1	738	384.94	3.50	388.44	592		535		13,979
Elk Creek	1		7	29.60		29.60	65				1,077
Gold Hill	5	21	91	52.53	4,082.92	4,135.45	624				144,937
Greenback [7]		1			5.00	5.00					175
Jacksonville	5	30	11,535	887.65	1,268.06	2,155.71	1,687	2,213			76,610
Upper Applegate	6	39	417	171.14	958.27	1,129.41	243				39,630
Wagner Butte	1		1	1.09		1.09					38
Undistributed [5]					309.22	309.22	68				10,851
Josephine County:											
Althouse	1	2	50	7.92	789.00	796.92	77				27,902
Galice	4	15	359	383.72	369.09	752.81	670	236			26,763
Grants Pass	1	8	1	2.25	766.68	768.93	132				26,959
Greenback [7]	3	6	6,184	83.99	694.00	777.99	339	696			27,466
Illinois River	2	25	103	73.75	518.62	592.37	81				20,755
Lower Applegate	3	2	553	61.15	280.08	341.23	54				11,961
Murphy		1			9.20	9.20	2				323
Rogue River		2			21.41	21.41	4				751
Waldo	2	10	601	283.81	444.37	728.18	97				25,513
Undistributed [5]					453.00	453.00	73				15,879
Lake County: New Pine Creek	1		1	3.50		3.50	9				128
Lane County: Bohemia	3	1	581	875.65	34.00	909.65	655	3,850	11,800		32,960
Lincoln County:											
Agate Beach		1			5.03	5.03	1				177
Beach		(6)			52.86	52.86	10				1,853
Collins Creek		1			16.74	16.74	3				587
Linn County: Quartzville		1			20.91	20.91	6				735
Malheur County:											
Malheur		(6)			33.23	33.23	5				1,164
Mormon Basin [4]	3	6	551	167.79	66.59	234.38	169				8,301
Morrow County: Boardman		1			1.41	1.41					49
Umatilla County: Umatilla		1			7.56	7.56					264
Union County: Camp Carson		1			3.00	3.00					105
Wheeler County: Spanish Gulch		2			53.01	53.01	8				1,858
Combined districts [8]	4	3	414	203.73	112.47	316.20	693	2,097	28,062	73,184	15,852
Total Oregon, 1934	95	332	62,145	11,471.68	22,239.91	33,711.59	[2] 46,560	38,373	41,603	73,184	1,216,075
1933	111	292	11,557	5,456.90	14,782.76	20,239.66	20,760	11,453	9,379	12,290	[9] 526,188

[1] Only those districts shown separately for which Bureau of Mines is at liberty to publish figures; other producing districts listed in footnote 8 and their output included under "Combined districts."

[2] Of the 46,560 ounces of silver produced in 1934, 42,983 ounces were from lode mines and 3,577 ounces from placers.

[3] Greenhorn district lies in both Baker and Grant Counties.

[4] Mormon Basin district lies in both Baker and Malheur Counties.

[5] No information as to district location or number of producers.

[6] No information as to number of producers.

[7] Greenback district lies in both Jackson and Josephine Counties.

[8] Includes following districts: Cow Creek, Baker County; Powers and Rock Creek, Coos County; South Myrtle Creek, Douglas County; and North Santiam, Marion County. Includes also 29.04 ounces of placer gold and 5 ounces of placer silver that could not be allocated to counties.

[9] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

EASTERN OREGON

Baker County.—Baker County supplied 60 percent of the lode gold, 21 percent of the placer gold, 81 percent of the total silver, and 68 percent of the copper produced in Oregon in 1934. This output, plus a nominal production of lead, was valued at $427,269, or 35 percent of the State total.

In the Cornucopia district operations of the Cornucopia Gold Mines, Inc., at Cornucopia constituted the major mining development in the State. This company was the largest producer of gold and silver in Oregon in 1934, having an output of 4,772 ounces of gold, 19,538 ounces of silver, and 16,250 pounds of copper. The new low-level tunnel, begun in December 1933 to intersect the Whitman, Last Chance, Union-Companion, and other veins at depths of 400 to 1,200 feet below present workings, was driven nearly 3,000 feet to a point approximately halfway to its ultimate objective. About 5,000 feet of drifts, crosscuts, and raises were completed, and 23,232 tons of ore and 10,652 tons of old tailings were treated. Besides free gold, the ore contains petzite, a telluride of gold and silver; it also contains auriferous and argentiferous pyrite and chalcopyrite which are recovered in a 100-ton flotation plant. A 400-ton flotation plant was placed in operation December 1, 1934, to treat 120,000 tons of cyanide-plant tailings estimated to carry $3 per ton in gold. Considerable placer mining, also was done in the Cornucopia district along Pine Creek; the Pine Creek Mining Co. operated a drift mine 8 miles northwest of Halfway the entire year and was the largest placer producer in the section. In the Cow Creek district the Harrison Gold Dredging Co. made a small gold production with a drag-line outfit from claims on Cow Creek. In the Greenhorn district the Red Bird mine 7 miles north of Tipton operated for 3 months, and ore yielding $20 in gold to the ton was treated in its 5-stamp mill; the Winterville placers on Bennett, Winterville, and Camp Creeks 9 miles northwest from Whitney were hydraulicked from April to July, inclusive, and yielded 96 ounces of gold from approximately 40,000 cubic yards of gravel. In the Mormon Basin district the Rainbow mine of Condor Gold Mines, Inc., with an output of 1,222 ounces of gold and 361 ounces of silver, was the largest producing lode property, but the company ceased operations late in October due to financial difficulties; the Pioneer Gold Dredging Co. operated its dredge on Clarks Creek 4 miles south of Bridgeport during the entire year and handled 480,000 cubic yards of gravel, yielding the largest output of placer gold in the district; and Smith and Harms handled 70,000 cubic yards of gravel with a drag line on the Nugget Association claim on Burnt River 2½ miles northeast of Bridgeport from June to October but found recoveries too low to continue operations in 1935. In the Pine Creek district drifting at the Elliott placer near Hereford during the first 7 months of the year resulted in an output of 36 ounces of gold. In the Rock Creek district the Baisley Elkhorn mine 16 miles west of Baker was the largest producer of lode gold. In the Sumpter district ore and concentrates, principally from the Bay Horse mine, produced prior to 1923 and stored at the old Sumpter smelter were shipped in 1934 to the Tacoma smelter and yielded high values in silver; ore shipped to the Tacoma smelter from the Columbia and Taber Fraction yielded the largest output of lode gold. A new operation by L. P. Harmon and associates on the North Powder River made the largest placer output in the Sumpter district; a Diesel-powered drag line delivered gravel to a Diesel-powered screening, washing, and stacking plant mounted on railroad-car trucks, and the reported cost of excavating and sluicing did not exceed $0.08 a cubic yard. The Sumpter Valley Dredging Co. began construction of a 9-cubic foot dredge at its property in the Sumpter district on the south side of Sumpter Valley.

Grant County.—Grant County ranked third in value of metal output in Oregon in 1934, advancing from fourth place in 1933, and contributed 25 percent of the total placer gold and 6 percent of the total lode gold.

The Timms Gold Dredging Co. operated its electric dredge on the Middle Fork of John Day River 23 miles west of Austin the entire year; approximately 516,000 cubic yards of gravel were handled to yield the largest output of placer gold in the State. The Empire Gold Dredging Co. operated an electric dredge on the John Day River on claims 1 mile west of Prairie City until June 15, when the property was purchased by the Monarch Gold Dredging Co. which ran the dredge continuously until December 22 and handled 130,000 cubic yards of gravel. The Gem mine in the Susanville district was the largest producer of lode gold in Grant County; it is equipped with a small flotation plant, and the concentrates were shipped to the Tacoma smelter. Next in order of production of lode gold were the Cougar Ridge mine (Quartzburg district), Buffalo-Monitor (Granite district), and Midnite and Colorado mines (Quartzburg district).

Malheur County.—Half a dozen small placer operations in the Mormon Basin district and a few itinerant miners in the Malheur district produced nearly 100 ounces of fine gold, the total output of placer gold in Malheur County in 1934. At the Sunday Hill lode mine in the Mormon Basin district, inactive in 1933, 400 tons of ore treated by amalgamation and tabling yielded 120 ounces of gold and 35 ounces of silver in 1934; the ore was crushed in a 5-stamp mill which has been replaced by a 50-ton flotation plant installed during the fall and scheduled for operation in March 1935.

Wheeler County.—The Spanish Gulch Gold Mining Co. carried on a small hydraulic operation near Antone in the Spanish Gulch district from March 17 to June 15, 1934, when it was closed down by water shortage; only 1,200 cubic yards of gravel were treated.

Other counties.—The total value of the gold and silver produced in Gilliam, Harney, Lake, Morrow, Umatilla, and Union Counties in 1934 was $1,036, of which $906 was in placer gold; no base metals were produced.

WESTERN OREGON

Coos County.—Placer operations in the Johnson Creek and Randolph districts yielded $3,459 in gold and silver, or 81 percent of the total placer output of Coos County in 1934; the rest of the placer gold was recovered from beach sands at Bandon and around Coos Bay. The Iron Dyke mine near Powers was the only operating lode mine in the county.

Curry County.—Of the total gold and silver produced in Curry County in 1934, valued at $13,314, virtually all came from beach sands in the vicinity of Sixes River and Gold Beach. The largest producer was J. F. T. Kirkup who operated at Cape Blanco, 5 miles from Sixes, where approximately 2,000 cubic yards of sand were mined with a gasoline shovel and washed over tables. Some platinum metals also were recovered.

Douglas County.—Gold and silver recovered in 1934 from placers in Douglas County were valued at $14,702 and came largely from small producers and itinerant miners along Cow Creek. The Chieftain mine (Nugget district), the Huckleberry mine (Riddle district), and the Hall mine (South Myrtle Creek district) were the only lode producers; the value of their output was less than half the placer value. A 2-stamp mill was installed at the Huckleberry mine.

Jackson County.—In 1934 Jackson County, with a metal production valued at $287,297 (24 percent of the State total), was supplanted by Baker County as the largest producing county in Oregon. Continued droughts and a consequent subnormal water season reduced its placer output considerably. Of the 8,154 ounces of gold produced placers yielded 81 percent and lode mines 19 percent. Small quantities of copper and lead were recovered as byproducts in gold mining. The Gold Hill, Jacksonville, and Upper Applegate districts produced 91 percent of the total gold output of the county.

Near Central Point a suction nozzle guided by a diver was used to clean the bedrock along Rogue River, raising the sand and gravel to a sluice. Operations at the Sterling hydraulic mine in the Upper Applegate district were hampered by lack of water, and only about 2,000 cubic yards of gravel were handled during the 2 weeks in April when the mine was worked. The Pacific placer, bordering Applegate River and Williams Creek, was taken over by new interests, but because of water shortage production was small. The three largest lode producers in Jackson County were the Opp (Jacksonville district), Ashland (Ashland district), and the Great I Am (Upper Applegate district). At the Opp mine the Pacific State Mines, Inc., operated its 100-ton flotation mill and shipped gold concentrates. Development work continued at the Ashland mine, and the 600-foot level was reached in the South Shaft. (The 700-foot level was reached early in 1935.) Continued increase of ore values and widening of the vein were reported. At the Great I Am mining continued from April to the end of the year, and the ore was treated in a 4-stamp mill. At the Norling mine about 10 miles west of Medford 260 tons of ore were mined, and a small tonnage of concentrates was shipped.

Josephine County.—Josephine County ranked fourth in production of metals in 1934 with a value of $184,272. The output of both lode and placer gold increased, the placers yielding 743 ounces and the lode mines 104 ounces more than in 1933. Much of the placer gold in Josephine County came from small placer workings along the tributaries of Illinois and Rogue Rivers in the Althouse, Grants Pass, Greenback, Illinois River, Waldo, Galice, and Lower Applegate districts.

The largest placer producers were the Althouse, Blue Channel, and Stove Pipe mines, all hydraulic properties in the Greenback district. The outstanding lode producers were the Rainbow mine in the Waldo district and the J. C. L. mine in the Galice district, and they were the only ones yielding more than 200 ounces of gold. Lode mines with individual outputs of 50 to 100 ounces of gold were the Gold Bond and California in the Galice district, the Black Cat (old Eureka) in the Illinois River district, and the Humdinger in the Lower Applegate district. Old tailings from the Greenback mine in the Greenback district were treated in a 100-ton flotation mill.

Lane County.—The metal production of Lane County in 1934, valued at $32,960, was largely lode gold from the Helena and Champion mines in the Bohemia district. The output of placer gold (34 ounces) was recovered almost entirely by a few itinerant miners in the Bohemia district.

Other counties.—Lincoln, Linn, and Marion Counties contributed an aggregate of $8,250 to the value of metal production in 1934.

GOLD, SILVER, COPPER, AND LEAD IN SOUTH DAKOTA

(MINE REPORT)

By Chas. W. Henderson

SUMMARY OUTLINE

Metal-mining history in South Dakota began with the discovery of placer gold in 1875 in the gravels of French Creek near the present site of Custer. Through 1934 metal mining has been confined to the three southwestern counties—Custer, Lawrence, and Pennington—in what is known as the Black Hills. In 1934 the metal mines of the State produced 486,118.97 fine ounces of gold and 99,741 fine ounces of silver compared with an output in 1933 of 512,403.77 ounces of gold (the largest in any year on record) and 125,417 ounces of silver. The Homestake mine at Lead, Lawrence County, long the largest producer of gold in the United States, was operated without interruption throughout the year, and in addition important changes were made in plants and equipment. This mine has been producing almost continuously since 1876. In 1933 it yielded, as usual, the bulk of the gold output of the State; in that year South Dakota ranked second only to California among the States as a gold producer and exceeded Alaska and the Philippine Islands. In 1934, despite increases in production at properties other than the Homestake, South Dakota ranked below California and Alaska. The second largest gold producer in the State during 1934 was the Decorah-Portland-Two Johns group of mines at Trojan, and the third was the Monarch in the Two Bit district; both are in Lawrence County. There were five other producing lode mines in South Dakota in 1934, but their total output was small. Placer operations yielded 1,080.20 ounces of gold in 1934 compared with 1,269.75 ounces in 1933. The total production of gold, silver, copper, and lead (in terms of recovered metals) in South Dakota from the beginning of production in 1875 to the end of 1934, as compiled by Chas. W. Henderson, has been 15,902,134 fine ounces of gold, 8,234,979 fine ounces of silver, 195,691 pounds of copper, and 568,313 pounds of lead.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95

per ounce, the average weighted yearly United States Government prices.[1] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, and lead in South Dakota, 1930–34, in terms of recovered metals [1]

Year	Mines producing			Ore (short tons)	Gold (lode and placer)		Silver (lode and placer)		Lead		Total value
	Lode	Placer	Total		Fine ounces	Value	Fine ounces	Value	Pounds	Value	
1930	2	8	10	1,365,156	407,221.14	$8,418,008	105,236	$40,516			$8,458,524
1931	6	83	89	1,404,153	432,075.39	8,931,791	113,562	32,933			8,964,724
1932	8	217	225	1,409,893	480,337.58	9,929,459	126,195	35,587	7,000	$210	9,965,256
1933	4	215	219	1,432,555	512,403.77	[2] 13,097,040	125,417	43,896			[2] 13,140,936
1934	8	258	266	1,520,669	486,118.97	16,989,858	99,741	64,479			17,054,337

[1] For total production of gold and silver in South Dakota, by years, see Henderson, Chas. W., Mineral Resources, 1913, pt. I, p. 42; Mineral Resources, 1922, pt. I, p. 194; and subsequent volumes of Mineral Resources and Minerals Yearbook.

[2] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold and silver produced at placer mines in South Dakota, 1930–34, in terms of recovered metals

Year	Gold		Silver		Total value
	Fine ounces	Value	Fine ounces	Value	
1930	47.41	$980	5	$2	$982
1931	96.17	1,988			1,988
1932	1,095.16	22,639	85	24	22,663
1933	1,269.75	[a] 32,455	97	34	[a] 32,489
1934	1,080.20	37,753	85	55	37,808

[a] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

[1] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28

Gold and silver produced at placer mines in South Dakota in 1934, by counties, in fine ounces, in terms of recovered metals

County	Sluicing and hydraulic		Dry-land dredges [1]		Total	
	Gold	Silver	Gold	Silver	Gold	Silver
Custer	82.10	7	446.71	27	528.81	34
Lawrence	139.82	16	106.59	12	246.41	28
Pennington	286.53	21	18.45	2	304.98	23
	508.45	44	571.75	41	1,080.20	85
Total, 1933	348.50	41	921.25	56	1,269.75	97

[1] Drag-line and power-shovel excavators with sluices or special amalgamators.

MINING AND METALLURGIC INDUSTRY

All the ores mined in South Dakota in 1934 were classed as dry gold ores, of which 1,440,715 tons were treated by amalgamation followed by cyanidation of sands and slimes, 79,617 tons by cyanidation only, and 337 tons by amalgamation only. Operating details at both lode and placer mines are given in the following review by counties.

METALLURGIC RECOVERY

Gold and silver bullion produced at mills in South Dakota by amalgamation, 1930–34

Year	Ore treated	Gold in bullion	Silver in bullion	Quicksilver used
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*
1930	1,364,456	270,448.01	65,265	12,021
1931	1,404,106	288,155.99	67,857	15,305
1932	1,402,275	310,637.81	72,639	7,633
1933	1,432,555	328,449.02	71,985	29,410
1934	1,441,052	310,941.73	58,086	9,663

Gold and silver bullion produced at mills in South Dakota by cyanidation, 1930–34

Year	Material treated			Gold in bullion product	Silver in bullion product	Sodium cyanide used [1]
	Crude ore	Sands and slimes	Total			
	Short tons	*Short tons*	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*
1930	700	1,348,144	1,348,844	136,725.72	39,966	382,110
1931	47	1,400,191	1,400,238	143,823.23	45,705	375,535
1932		1,396,330	1,396,330	168,561.00	50,166	437,773
1933		1,430,738	1,430,738	182,685.00	53,335	447,172
1934	79,617	1,432,045	1,511,662	174,097.04	41,570	[2] 519,724

[1] In terms of 96- to 98-percent strength.
[2] Actually 1,032,066 pounds of cyanamid (49-percent strength) and 3,691 pounds of sodium cyanide (96- to 98-percent strength); cyanamid reduced to equivalent of 96- to 98-percent strength to conform with earlier use of figures for high-strength NaCN and KCN.

REVIEW BY COUNTIES

CUSTER COUNTY

Mine production of gold and silver in Custer County, S. Dak., 1930–34, in terms of recovered metals

Year	Mines producing (all placer)	Gold (all placer)		Silver (all placer)	Total value
		Fine ounces		*Fine ounces*	
1930	4	6.34	$131		$131
1931	41	45.57	942		942
1932	80	697.81	14,425	50	14,439
1933	52	893.63	[1] 22,841	57	[1] 22,861
1934	44	528.81	18,482	34	18,504

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

The C. Palmer placer operation on French Creek one-half mile west of Custer, equipped with a drag-line excavator and sluice boxes, was the largest producer of gold in Custer County in 1934. Only a small output was made from the Grand Hills Mining Co. steam shovel-Ainlay bowl installation, also on French Creek near Custer. After operating for a short period on French Creek, the Peerless Mining Co. moved its equipment of four Ainlay centrifugal 36-inch bowls and one 1¼-yard gasoline power shovel to Tarryall Creek, Park County, Colo. A drag-line excavator and sluice box, used during 1 month's operation at the Dorothy Van placer, recovered 13.09 ounces of placer gold 0.924 fine. Small lots of placer gold were recovered by individuals sluicing on French Creek and on Battle Creek near the Pennington County line.

No production was made from lode mines in Custer County in 1934. At the Golden Crown mine 3½ miles west of Custer a 10-ton stamp mill was built, but it made no output during the year.

LAWRENCE COUNTY

Mine production of gold, silver, and lead in Lawrence County, S. Dak., 1930–34, in terms of recovered metals

Year	Mines producing		Ore	Gold (lode and placer)		Silver (lode and placer)	Lead	Total value
	Lode	Placer						
			Short tons	*Fine ounces*		*Fine ounces*	*Pounds*	
1930	1	4	1,364,456	406,879.08	$8,410,937	105,184		$8,451,433
1931	2	22	1,403,964	431,916.77	8,928,512	113,507		8,961,429
1932	3	17	1,409,211	479,300.90	9,908,029	126,103	7,000	9,943,800
1933	3	21	1,432,285	511,289.36	[1] 13,068,556	125,340		[1] 13,112,425
1934	4	43	1,520,578	485,223.18	16,958,550	99,680		17,022,990

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Homestake mine.—The Homestake mine and mills were operated continuously in 1934. The new 5,000-foot, 3-compartment, 13- by 19-foot Ross shaft, authorized November 30, 1932, was completed to the 3,200-foot level (partly by sinking and partly by raising from below) and placed in operation to the 2,900-foot level during 1934. The capacity of the South mill was increased from 1,960 to 3,900 tons per 24 hours, and the equipment on January 28, 1935, included 180 stamps, 1,180 square feet of amalgamating plates and 12 Clark-Todd amalgamators, 10 rod mills, 4 tube mills, 2 ball mills, 16 Dorr drag classifiers, 14 cone classifiers, and 3 thickening tanks. During the year operation of the old Amicus and Pocahontas mills was discontinued. The company operated three other mills in 1934: Cyanide sand plant No. 1, capacity 1,500 tons; cyanide sand plant No. 3, 1,000 tons; and slime plant, 1,600 tons. Ore from the Homestake mine to the company mills, treated by amalgamation followed by cyanidation of sands and slimes, totaled 1,440,692 tons in 1934, an increase of 8,497 tons over 1933, and revenue from the sale of gold-silver bullion bars and a small quantity of assay laboratory slag was $16,515,684—$3,615,367 more than in 1933. Dividends paid in 1934 were $7,534,800. From 1876 to 1934, inclusive, this mine has yielded bullion and concentrates which brought a cash return of $282,810,490 after freight, express, insurance, mint, and smelter charges are deducted; the company has paid $73,955,482 in dividends.

The annual report of the general manager of the Homestake Mining Co. for the year ended December 31, 1934, says:

During the year just past there have been important changes in plants and equipment at the Homestake. Ore hoisting on regular schedule at the Ross shaft started November 19, 1934. The enlarged South mill is now handling the entire mine output. This mill with Cyanide No. 1 and No. 3 plants constitute a compact economical metallurgical group. No time was lost while making these changes, and production for the year was normal.

The B. & M. hoist, Amicus and Pocahontas mills, and Cyanide No. 2 plant have been shut down.

Following is a condensed report of the mine engineer:

There are 425,717 tons of ore broken down and remaining in the stopes.

There are 15,148,219 tons of ore blocked out and remaining in the mine.

The Ellison Shaft is now completed to the 3,200-foot level.

The Ross Shaft is completed to the 3,200-foot level with the exception of a rock bulkhead 33 feet thick between the 2,900-foot and 3,050-foot levels.

Construction of the Kirk power plant is progressing rapidly and should be completed about June 1, 1935.

Ore milled, receipts, and dividends, Homestake mine, 1930–34 [1]

Year	Ore milled	Receipts for bullion product		Dividends
		Total	Per ton	
	Short tons			
1930	1,364,456	$8,426,195.21	$6.1755	$2,009,280
1931	1,403,939	8,935,307.15	6.3645	2,122,302
1932	1,401,593	9,911,858.40	7.0719	2,662,296
1933	1,432,195	12,900,316.78	9.0074	3,767,400
1934	1,440,692	16,515,684.14	11.4637	7,534,800

[1] From 1876 to 1934, inclusive, this mine yielded bullion and concentrates which brought $282,810,490 and paid $73,955,482 in dividends.

Other mines.—The Bald Mountain Mining Co., which in 1928 bought the property of the Trojan Mining Co. (an important producer in the Bald Mountain area until 1923), began work on reconditioning the mine and the old Trojan cyanide mill in November 1933. The company operated the mine throughout 1934 and the mill from January 20 at a daily average of 224 tons, which included some custom ores. The all-sliming cyanide method of treatment was used. The mill equipment consists of one Gates No. 5-K crusher, 2 ball mills, 2 Dorr duplex classifiers, 3 Portland filters, 5 agitation tanks, 5 thickening tanks, and Merrill-Crowe precipitation equipment. Only oxidized dry siliceous gold ores were treated in 1934. With regard to other types of ores found in this property and elsewhere in the district, the company report dated January 29, 1935, states:

A small experimental plant capable of treating 5 tons a day has been recently placed in operation. The purpose of this plant is to determine the best means of treating refractory sulphide ores, commonly known as blue ores. The treatment includes a roast, the exact character of which is to be determined, and if successful may lead to the treatment of these ores on a commercial scale.

At the Monarch mine in the Two Bit district the Black Hills Mining Corporation treated "brown" gold ore by the all-sliming method in its 25-ton cyanidation mill built in 1932–33. The mill was operated at an average of 10 tons a day. The property is opened by a 1,000-foot adit and 2,000 feet of drifts, of which 500 feet were driven in 1934.

The Anaconda Mining & Milling Co. unwatered extensive old workings on 6 levels at the Clover Leaf mine in the Bear Butte district, repaired surface buildings, and installed new equipment in the 60-stamp amalgamation mill on the property.

On November 15, 1934, the Canyon Corporation started remodeling the mill at the long-idle Maitland mine, in the Maitland district 3 miles northwest of Blacktail, to a 125-ton roasting and cyanidation mill, to treat the "blue" ores of that property—gold in a siliceous gangue with pyrite and arsenopyrite.

The New Deal Mining Co. in 1934 cleaned out old workings of its properties at the head of Gimlet Creek, about 5 miles northeast of Rochford, and built a 10-ton stamp amalgamation mill; treatment of dry siliceous gold ores from the Fox Squirrel claim was begun October 17 and was continued at a daily average of 6 tons for 45 days during the remainder of the year.

The Bear Creek Mining Co. worked its placer ground on Iron Creek with a power shovel and bowl classifier for 2 weeks during the year; operation was then discontinued owing to lack of water, and the equipment was moved to Whitewood Creek where the bulk of the company output was produced. Small panning, rocking, and sluicing operations, principally in Bear Gulch and on Iron and Potato Creeks in the Rawlings district and in Blacktail Gulch and on Deer, Two Bit, and Whitewood Creeks, yielded the remainder of the placer gold produced in Lawrence County in 1934.

PENNINGTON COUNTY

Mine production of gold and silver in Pennington County, S. Dak., 1930–34, in terms of recovered metals

Year	Mines producing		Ore	Gold (lode and placer)		Silver (lode and placer)	Total value
	Lode	Placer					
			Short tons	*Fine ounces*		*Fine ounces*	
1930	1		700	335.72	$6,940	52	$6,960
1931	4	20	189	113.05	2,337	55	2,353
1932	5	120	682	338.87	7,005	42	7,017
1933	1	142	270	220.78	[1] 5,643	20	[1] 5,650
1934	4	171	91	366.98	12,826	27	12,843

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

A shipment of gold ore was made from the Egyptian mine in the Keystone district to the Golden Cycle mill at Colorado Springs, Colo. The Western Bell mine was operated intermittently, the ore being treated at a 2-stamp mill erected on an adjoining claim; the owners reported lack of water for continuous operation. Amalgamation bullion was shipped to the Denver Mint from the Pay Day mine near Hill City and from the Hornblende mine in the Hornblende district. At the Golden Slipper mine in the Hill City district a new 300-ton flotation-cyanidation mill with a 250-kw generating plant was built; development work, including retimbering and unwatering, was done in the mine.

The output from placers in Pennington County totaled 304.98 ounces of gold and 23 ounces of silver, recovered chiefly by many small sluicing operations on Battle, Castle, Rapid, and Spring Creeks. Hydraulicking was reported at one placer, the King Midas, on Rapid Creek in Canyon City Gulch.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN TEXAS

(MINE REPORT)

By Chas. W. Henderson

SUMMARY OUTLINE

In 1934 the production of gold, silver, copper, and lead in Texas was stimulated greatly by the Presidential Order of December 21, 1933, fixing the price of silver at $0.64646464+ per ounce, the highest price paid producers of silver since 1925. This action led to the reopening of the Presidio mine in Presidio County, one of the largest producers of silver in the United States and the most important producer of gold and lead (recovered in relatively small quantities with silver) in Texas. The Hazel mine in Culberson County, a producer of silver and copper, was also reopened; it yielded most of the State output of copper during the year. Production from other mines and prospects was small. Details of Texas mine output are given in the following tables and text.

The total production of gold, silver, copper, lead, and zinc in Texas (in terms of recovered metals) from the beginning of production in 1885 to the end of 1934, according to Henderson,[1] has been 4,967 fine ounces of gold, 23,628,547 fine ounces of silver, 1,338,960 pounds of copper, 4,500,126 pounds of lead, and 1,488,474 pounds of zinc.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly United States Government prices.[2] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

[1] For production from 1885 to 1927 and prices used in calculating values see Henderson, Chas. W., Mineral Resources, 1927, pt. I, pp. 477–478. *See also* Henderson, Chas. W., Mineral Resources, 1914, pt. I, p. 236.

[2] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

MINE PRODUCTION

Mine production of gold, silver, copper, and lead in Texas, 1930–34, in terms of recovered metals [1]

Year	Ore (short tons)	Gold		Silver		Copper		Lead		Total value
		Fine ounces	Value	Fine ounces	Value	Pounds	Value	Pounds	Value	
1930	31,147	176.47	$3,648	389,239	$149,857	143,100	$18,603	396,820	$19,841	$191,949
1932	185	8.66	179	1,422	401	7,000	441	34,000	1,020	2,041
1933	63			160	56	2,000	128	6,000	222	406
1934	47,680	358.74	12,538	854,442	552,367	29,000	2,320	719,000	26,603	593,828

[1] No production in 1931.

Mine production of gold, silver, copper, and lead in Texas in 1934, by counties, in terms of recovered metals

County	Mines producing	Ore (short tons)	Gold (fine ounces)	Silver (fine ounces)	Copper (pounds)	Lead (pounds)
Brewster	1	28	1.40	549		1,000
Culberson	1	941	.29	13,359	28,800	300
Hudspeth	2	4		79	200	100
Presidio	4	46,707	357.05	840,455		717,600
	8	47,680	358.74	854,442	29,000	719,000

REVIEW BY COUNTIES

Brewster County.—One car of lead-silver ore was shipped in 1934 from Alpine to the El Paso smelter.

Culberson County.—The Hazel mine, 14 miles north of Van Horn, was operated during the last 4 months of 1934 and produced silver-copper ore which was shipped crude to the El Paso smelter.

El Paso County.—At El Paso are the lead and copper plants of the American Smelting & Refining Co. At the end of 1934 the copper works consisted of 2 reverberators, with a total annual capacity of 600,000 tons of ore, and 3 converters; the lead plant was equipped with 3 furnaces having a total annual capacity of 200,000 tons. The lead plant treats lead ore and concentrates from Arizona, New Mexico, and Texas and lead ore in bond from Mexico. The copper plant was built originally in 1910 to handle copper concentrates from Chino Mines at Santa Rita, N. Mex.; it also receives copper ore and concentrates from Arizona. Natural gas for fuel was introduced in these plants in 1930.[3] Both plants were operated intermittently in 1934.

The Nichols electrolytic copper refinery, also at El Paso, was completed and set in operation in 1930 to treat copper anodes produced at the Arizona smelters of the Phelps Dodge Corporation and the Calumet and Arizona Mining Co. The yearly capacity is 100,000 tons of anodes.[4] The plant was not operated at full capacity during 1934.

Hudspeth County.—A small lot of copper-lead ore from the Mohawk mine and a small lot of dry silver ore from one other mine in the Allamoore district were shipped to the El Paso smelter in 1934.

Presidio County.—On January 1, 1934, the American Metal Co. reopened its Presidio mine at Shafter, closed since June 30, 1930, when silver prices became too low for profitable operation. The mine and 185-ton gravity concentration-cyanidation mill were operated continuously throughout 1934. The ore is found as a replacement of limestone beds and is oxidized, the principal mineral being silver chloride associated with argentite, cerargyrite, galena, and cerussite. It is brought to the mill by a 1-mile aerial tramway and crushed; the product is concentrated by gravity and the slimes are cyanided.

The following table shows the total number of tons treated, silver content of mill heads (per ton and total), and recovery of silver (percentage and total).

Production of silver from the Presidio mine,[1] 1885–1934 [2]

Period	Mill heads treated (short tons)	Silver content of mill heads (ounces)		Recovery of silver	
		Per ton	Total	Percent	Ounces
1885–1912	450,000	25.84	11,628,000	81.68	9,497,750
1913–26	720,000	12.00	8,640,000	83.66	7,228,224
1927	48,190	22.87	1,102,105	[3] 91.41	[3] 1,004,384
1928	57,475	23.17	1,331,696	91.04	1,212,340
1929	54,644	19.74	1,078,673	90.30	974,049
Total, 1885–1929	1,330,309	17.88	23,780,474		19,916,747
1930	24,985	(?)	(?)	(?)	365,439
1934	46,653	19.70	919,064	91.39	839,936
Total, 1885–1934	1,401,947	(?)	(?)	(?)	21,122,122

[1] Howbert, Van Dyne, and Gray, F. E., Milling Methods and Costs at Presidio Mine of the American Metal Co. of Texas: Am. Inst. Min. and Met. Eng. Tech. Pub. 368, 1930.
Howbert, Van Dyne, and Bosustow, Robert, Mining Methods and Costs at Presidio Mine of the American Metal Co. of Texas: Am. Inst. Min. and Met. Eng. Tech. Pub. 334, 1930.
[2] No production in 1931, 1932, and 1933.
[3] Using the company's 1927 report of 1,004,384 ounces of silver recovered gives 91.13 percent recovery; using 91.41 percent (Howbert and Gray, work cited, p. 6) as recovery gives 1,007,434 ounces of silver recovered.

[3] Marble, E. R., Natural-Gas Firing at El Paso Smelting Works: Min. and Met., October 1930, pp. 466–467.
[4] Robie, E. H., A Trip Through the New Nichols Copper Refinery at El Paso, Tex.: Eng. and Min. Jour., vol. 129, January 1930, pp. 5–10; Furnace and Casting Equipment of the New Nichols Refinery: Eng. and Min. Jour., vol. 129, January 1930, pp. 73–76.
Corwin, F. R., and Harloff, C. S., El Paso Refinery of the Nichols Copper Co.: Min. and Met., October 1930, pp. 459–465.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH

(MINE REPORT)

By C. N. Gerry and T. H. Miller [1]

SUMMARY OUTLINE

The output of gold, silver, copper, lead, and zinc from Utah mines in 1934, in terms of recovered metals, was 136, 581.52 fine ounces of gold, 7,111,417 fine ounces of silver, 86,024,925 pounds of copper, 116,153,945 pounds of lead, and 56,396,279 pounds of zinc. This output compares with a production in 1933 of 109,129.55 ounces of gold, 5,669,197 ounces of silver, 73,583,130 pounds of copper, 117,-376,556 pounds of lead, and 59,489,193 pounds of zinc. There were 190 lode mines and 28 placers producing in 1934 compared with 121 lode mines and 21 placers in 1933.

Since 1864 the output of the five metals in Utah has been as follows: Gold, 7,136,891 fine ounces; silver, 605,217,887 fine ounces; copper, 4,941,679,034 pounds; lead, 7,312,744,665 pounds; and zinc, 1,040,670,-436 pounds. The total value of this output has been $1,837,823,082.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly United States Government prices.[2] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

[1] Assisted by Paul Luff and Jeannette Froiseth.

[2] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, copper, lead, and zinc in Utah, 1930–34, in terms of recovered metals

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1930	103		11,041,841	208,455.03	$4,309,148	13,129,421	$5,054,827
1931	96	9	8,954,617	198,740.12	4,108,323	8,290,966	2,404,380
1932	86	19	3,768,542	135,256.35	2,795,997	6,962,097	1,963,311
1933	121	21	4,116,935	109,129.55	[1] 2,789,351	5,669,197	1,984,219
1934	190	28	5,076,735	136,581.52	4,773,524	7,111,417	4,597,280

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1930	180,526,423	$23,468,435	230,989,780	$11,549,489	88,990,938	$4,271,565	$48,653,464
1931	151,236,505	13,762,522	158,423,453	5,861,668	74,581,072	2,834,081	28,970,974
1932	64,964,111	4,092,739	125,552,966	3,766,589	59,331,888	1,779,957	14,398,593
1933	73,583,130	4,709,320	117,376,556	4,342,933	59,489,193	2,498,546	[1] 16,324,369
1934	86,024,925	6,881,994	116,153,945	4,297,696	56,396,279	2,425,040	22,975,534

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold.—The output of gold in Utah in 1934 was 136,581.52 ounces, an increase of 27,451.97 ounces (25.16 percent) over that in 1933. Gold recovered from siliceous ores and old tailings increased 23,327.55 ounces (47.88 percent); there was also a substantial increase from copper ore and from lead ore, but a decrease of nearly 6,000 ounces from lead-zinc ore. Siliceous ores and old tailings yielded 52.75 percent of the total gold, copper ore 32.34 percent, lead-zinc ore 11.17 percent, and lead ore and old slag 3.65 percent. Production of gold in the West Mountain (Bingham) district in 1934 increased more than 15,000 ounces over that in 1933 due chiefly to large gains from the Utah Copper, Utah-Apex, Utah-Delaware, and Boston Consolidated mines. The output in the Tintic district in 1934 was slightly more than in 1933; production from the Eureka Standard mine decreased nearly 8,000 ounces, but increases from other mines in the district, chiefly the Eureka Lilly and Centennial-Beck, more than offset the decrease. There was an increase of nearly 6,500 ounces in gold from the old Camp Floyd (Mercur) district due chiefly to increased output at the Manning tailings mill. There was also a good increase from the Gold Mountain district as a result of regular operations at the Annie Laurie mine.

The largest producers of gold in Utah in 1934 were the Utah Copper, Eureka Standard, United States & Lark, Manning, Utah-Delaware, Mammoth, and Eureka Lilly mines; these seven properties (each producing more than 4,500 ounces) yielded 76 percent of the State total. Other large producers (more than 2,000 ounces each) were the Utah-Apex, Live Yankee, Annie Laurie, and Silver King Coalition mines.

Placer mines in Utah yielded 128.04 ounces of gold in 1934 com pared with 142.51 ounces in 1933.

Silver.—The output of silver in Utah in 1934 was 7,111,417 ounces, an increase of 1,442,220 ounces (25.44 percent) over that in 1933; the State again ranked second as a silver producer, following Idaho. There was an increase of 1,057,550 ounces in silver from siliceous ores, chiefly silver ore, and also a good increase from lead-zinc ore, but a slight decrease from lead ore. Lead-zinc ore yielded 52.94 percent of the total silver and siliceous ores 27.56 percent; most of the remainder came from lead ore. The output of silver in the West Mountain (Bingham) district in 1934 increased nearly 659,900 ounces compared with 1933 due chiefly to large increases at the Lark, Utah-Apex, Utah-Delaware, and Utah Copper properties. The output in the Park City region increased 316,564 ounces, due to the reopening of the Park City Consolidated mine as production from the Silver King Coalition mine decreased. The output in the Tintic district increased 268,104 ounces, as increases at the Plutus, Centennial-Beck, and Chief Consolidated properties more than offset decreases at the Tintic Standard and Eureka Standard mines. There was also a substantial increase in silver from the Ophir-Rush Valley section of Tooele County.

The largest producer of silver in Utah in 1934 was the United States Smelting, Refining & Mining Co. (United States & Lark group), followed by the Silver King Coalition and Tintic Standard properties; these three producers (each with over 1,000,000 ounces) yielded 61.55 percent of the State total. Other large producers (each with more than 125,000 ounces) were the Park City Consolidated, Utah Copper, Eureka Standard, Plutus, Utah-Apex, and Bluestone properties.

Copper.—The output of recoverable copper in Utah in 1934 was 86,024,925 pounds, an increase of 12,441,795 pounds (16.91 percent) over that in 1933 due chiefly to the increase of more than 9,360,000 pounds by the Utah Copper Co. Large increases also were reported from the Lark, Utah-Apex, Boston Consolidated, Utah-Delaware, and Ohio Copper properties, all in the West Mountain district. Copper ore, mine-water precipitates, and mill clean-up yielded 92 percent of the total copper and siliceous gold ore and lead-zinc ore most of the remainder. About 87.5 percent of the total copper came from copper ore milled; the remainder came largely from crude siliceous gold ore and copper precipitates smelted and from lead-zinc ore milled.

The Utah Copper Co. was, as usual, the largest producer of copper in Utah, its output in 1934 being about 91 percent of the State total. Other producers of more than 400,000 pounds each were the United States & Lark, Utah-Delaware, Utah-Apex, Silver King Coalition, Boston Consolidated, and Ohio Copper properties, all at Bingham except the Silver King Coalition.

Lead.—The output of recoverable lead in Utah in 1934 was 116,153,945 pounds, a decrease of 1,222,611 pounds (1 percent) compared with 1933. Lead recovered from lead ore decreased more than 2,600,000 pounds and from lead-zinc ore nearly 2,300,000 pounds, but lead from siliceous ores increased more than 3,700,000 pounds. Lead-zinc ore and old tailings milled yielded 75 percent of the total lead, and crude lead ore smelted nearly 21 percent. Production of lead increased 1,607,200 pounds in the Park City region and 2,525,221 pounds in the Ophir district, but decreases of 1,435,620 pounds in the Tintic district, 1,219,461 pounds in the West Mountain district, and 2,644,965 pounds in the Rush Valley district more than offset the increases.

The largest producers of lead in Utah in 1934 were the United States & Lark, Silver King Coalition, Bluestone, and Tintic Standard properties; these four mines (each producing more than 7,600,000 pounds) yielded 85 percent of the State total. Other large producers (more than 1,000,000 pounds each) were the West Calumet, Utah-Apex, Hidden Treasure, Niagara, Ophir Hill Consolidated, and Chief Consolidated mines. Unusually large decreases in output of lead were reported at the United States & Lark, Bluestone, and Tintic Standard properties; substantial increases were made at the Utah-Apex, West Calumet, Hidden Treasure, Ophir Hill Consolidated, Silver King Coalition, Chief Consolidated, Plutus, Utah-Delaware, Park City Consolidətad, and Eureka Lilly mines.

Zinc.—The output of recoverable zinc in Utah in 1934 decreased 3,092,914 pounds (5.20 percent) from that in 1933. Production in the West Mountain (Bingham) district decreased more than 8,000,000 pounds due to the large drop in output at the United States mine, but production in the Park City region increased nearly 2,800,000 pounds, chiefly from the Silver King Coalition mine; there were also substantial increases in the Ophir and Rush Valley districts, Tooele County. All the zinc produced in Utah in 1934 came from lead-zinc ore, most of it by milling; a little came from crude ore smelted.

The largest producers of zinc in Utah in 1934 were the United States & Lark, Silver King Coalition, West Calumet, and Hidden Treasure mines; these four properties yielded nearly 96 percent of the State total. Other large producers were the Niagara, Park City Consolidated, and Ophir Hill Consolidated mines.

MINE PRODUCTION BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in Utah in 1934, by counties, in terms of recovered metals

County	Mines producing			Ore, old tailings, etc.	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total	Short tons	Fine ounces	Value	Fine ounces	Value
Beaver	9		9	349	21.23	$742	8,004	$5,174
Box Elder	8		8	220	81.89	2,862	14,765	9,545
Garfield	3	5	8	4	13.59	475	3	2
Grand		10	10		76.48	2,673	14	9
Iron	8		8	2,842	1,231.70	43,048	11,340	7,331
Juab	30		30	64,624	10,005.29	349,685	596,938	385,899
Millard	3	2	5	130	38.91	1,360	158	102
Piute	10		10	11,331	3,154.08	110,235	15,255	9,862
Salt Lake	30	7	37	4,507,119	77,565.84	2,710,926	2,691,282	1,739,819
San Juan		2	2		6.41	224		
Sevier	2		2	64	26.90	940	1,666	1,077
Summit	8		8	122,123	2,572.39	89,905	1,536,684	993,412
Tooele	52		52	224,887	10,779.06	376,728	362,478	234,329
Uintah	2	2	4	23	21.80	762	51	33
Utah	20		20	104,236	29,855.85	1,043,462	1,414,393	914,355
Wasatch	3		3	38,780	1,088.30	38,036	458,366	296,318
Washington	2		2	3	41.80	1,461	20	13
	190	28	218	5,076,735	136,581.52	4,773,524	7,111,417	4,597,280
Total, 1933	121	21	142	4,116,935	109,129.55	[1] 2,789,351	5,669,197	1,984,219

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Beaver	4,513	$361	16,648	$616	10,233	$440	$7,333
Box Elder	1,263	101	15,513	574			13,082
Garfield	250	20					497
Grand							2,682
Iron							50,379
Juab	536,312	42,905	2,555,054	94,537	17,488	752	873,778
Millard	912	73					1,535
Piute	3,825	306	12,216	452			120,855
Salt Lake	83,627,000	6,690,160	65,506,081	2,423,725	33,405,628	1,436,442	15,001,072
San Juan							224
Sevier							2,017
Summit	504,500	40,360	24,163,784	894,060	18,844,140	810,298	2,828,035
Tooele	437,963	35,037	14,323,838	529,982	3,556,256	152,919	1,328,995
Uintah	5,537	443	7,108	263			1,501
Utah	851,975	68,158	8,997,189	332,896	21,581	928	2,359,799
Wasatch	50,875	4,070	556,514	20,591	540,953	23,261	382,276
Washington							1,474
	86,024,925	6,881,994	116,153,945	4,297,696	56,396,279	2,425,040	22,975,534
Total, 1933	73,583,130	4,709,320	117,376,556	4,342,933	59,489,193	2,498,546	[1] 16,324,369

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

MINING INDUSTRY

The total value of the mine output in Utah increased from $16,324,369 in 1933 to $22,975,534 in 1934. The gain of $6,651,165 (40.74 percent) was substantial, but the total value in 1934 was far less than the annual average ($54,555,795) for the decade 1925–34. Improvement in prices of gold, silver, and copper was one of the chief factors that affected the Utah mining industry in 1934. The total value of the silver output increased $2,613,061 over 1933, that of copper

$2,172,674, and that of gold $1,984,173; the total value of the output of both lead and zinc decreased slightly. The increase in price per ounce of silver from 35 to 64.6+ cents and the increase in price of gold resulted in marked gain in the quantity of siliceous ores shipped crude to smelters. The general increase in mining activity was evident in all sections of the State. Increases in ore output were recorded in all the important producing districts, particularly the West Mountain (Bingham) district.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in Utah in 1934, with content in terms of recovered metals

Source	Mines producing	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold ore	71	[1] 361,061	62,114.01	644,015	2,579,222	1,779,300	
Dry gold and silver ore	23	60,315	6,741.34	298,060	746,045	658,884	
Dry silver ore	35	56,743	3,193.48	1,017,770	657,687	2,361,444	
	129	478,119	72,048.83	1,959,845	3,982,954	4,799,628	
Copper ore	17	[2] 4,092,303	44,169.71	375,137	[3] 79,090,638	4,086	
Lead ore	84	[4] 67,634	4,979.84	1,006,198	554,565	24,153,007	
Copper-lead ore	3	[5] 127	3.24	5,618	17,371	26,539	
Lead-zinc ore	22	[6] 438,552	15,251.86	3,764,602	2,379,397	87,170,685	56,396,279
	126	4,598,616	64,404.65	5,151,555	[3] 82,041,971	111,354,317	56,396,279
Total, lode mines	[7] 190	5,076,735	136,453.48	7,111,400	[3] 86,024,925	116,153,945	56,396,279
Total, placers	28		128.04	17			
	218	5,076,735	136,581.52	7,111,417	[3] 86,024,925	116,153,945	56,396,279
Total, 1933	142	4,116,935	109,129.55	5,669,197	[8] 73,583,130	117,376,556	59,489,193

[1] Includes 170,512 tons of old tailings treated by cyanidation.
[2] Includes 4,983 tons of old mill cleanings and 1 ton of old matte sold to a smelter.
[3] Includes 2,453,490 pounds of copper saved from precipitates.
[4] Includes 3 tons of old tailings and 2,428 tons of old slag sold to a smelter.
[5] Includes 4 tons of old slag sold to a smelter.
[6] Includes 10,121 tons of old tailings reconcentrated.
[7] A mine producing more than one class of ore is counted but once in arriving at total for all classes.
[8] Includes 4,107,381 pounds of copper saved from precipitates.

Value of metals from ore, old tailings, etc., sold or treated in Utah in 1934, by classes of ore

Class	Ore, old tailings, etc. (short tons)	Gold	Silver	Copper	Lead	Zinc	Total
Dry gold ore	361,061	$2,170,885	$416,333	$206,338	$65,834		$2,859,390
Dry gold and silver ore	60,315	235,610	192,685	59,683	24,379		512,357
Dry silver ore	56,743	111,612	657,952	52,615	87,374		909,553
Copper ore	4,092,303	1,543,731	242,513	[1] 6,327,251	151		8,113,646
Lead ore	67,634	174,045	650,472	44,365	893,661		1,762,543
Copper-lead ore	127	113	3,632	1,390	982		6,117
Lead-zinc ore	438,552	533,053	2,433,682	190,352	3,225,315	$2,425,040	8,807,442
	5,076,735	4,769,049	4,597,269	[1] 6,881,994	4,297,696	2,425,040	22,971,048
Total, 1933	4,116,935	[2] 2,785,709	1,984,214	[3] 4,709,320	4,342,933	2,498,546	[2] 16,320,722

[1] Includes value of 2,453,490 pounds of copper saved from precipitates.
[2] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67 + per ounce).
[3] Includes value of 4,107,381 pounds of copper saved from precipitates.

Gold ore.—Seventy-one properties produced 361,061 tons of siliceous gold material (including 170,512 tons of old tailings) in 1934 compared with 49 properties producing 139,473 tons (including 24,709 tons of old tailings and 1 ton of old slag) in 1933. All the old tailings in 1934 came from the Manning dump and were re-treated in a cyanidation plant. Most (179,924 tons) of the gold ore was smelted, 9,423 tons were treated at gold and silver mills, and 1,202 tons were concentrated. More than 84 percent of the total came from mines in the Tintic and West Mountain districts; most of the remainder came from the Gold Mountain and American Fork districts. The largest producers of gold ore were the Eureka Standard, Utah-Delaware, Mammoth, Eureka Lilly, Boston Consolidated, Utah Metal & Tunnel, United States & Lark, and Annie Laurie mines.

Gold and silver ore.—Twenty-three properties produced 60,315 tons of siliceous gold and silver ore in 1934 compared with nine properties producing 2,687 tons in 1933. All the ore produced in 1934 was shipped crude to smelters, and half of it came from the Utah-Apex mine at Bingham, reopened in 1934. Other large producers of gold and silver ore were the Centennial-Beck, United States & Lark, Empire, American Flag, and Victoria mines.

Silver ore.—Thirty-five properties produced 56,743 tons of siliceous silver ore (all of smelting grade) in 1934 compared with 10 properties producing 7,847 tons in 1933. About 65 percent of the total in 1934 came from mines in the Tintic district; most of the remainder came from a mine in the West Mountain district. The chief producers of silver ore were the Tintic Standard, Lark, Plutus, Chief Consolidated, American Flag, Centennial-Beck, and Apex Standard mines; large increases were recorded at all these properties.

Copper ore.—The output of copper ore, etc., increased from 3,524,073 tons in 1933 to 4,092,303 tons in 1934 (16 percent), due almost entirely to the increased rate of production at the Utah Copper property at Bingham, from which all but 520 tons of the copper material came.

Lead ore.—The output of lead ore, old slag, etc., from 84 properties in 1934 was 67,634 tons compared with 62,319 tons from 53 properties in 1933. The output in 1934 comprised 64,453 tons of first-class lead ore of smelting grade, 750 tons of milling ore, 2,428 tons of old slag smelted, and 3 tons of old tailings smelted. The output from the Bluestone and Tintic Standard properties (the largest producers of lead ore) decreased 11,522 tons from 1933, but large increases from the Utah-Apex, Ophir Hill Consolidated, West Calumet, United States & Lark, Chief Consolidated, and Utah-Delaware properties more than offset the decrease. About 35 percent of the total lead material came from mines in the Rush Valley district, 30 percent from the Tintic district, and 20 percent from the West Mountain district.

Copper-lead ore.—The output of copper-lead material in 1934 consisted of 123 tons of first-class smelting ore and 4 tons of old slag. The ore came from the Cardiff mine in the Big Cottonwood district and the Kearsarge Standard mine in the Ophir district.

Lead-zinc ore.—The output of lead-zinc ore and old tailings was 438,552 tons (including 10,121 tons of old tailings) from 22 properties in 1934 compared with 380,489 tons of ore from 13 properties in 1933. The increase in output was due chiefly to the reopening of the Park

City Consolidated and Utah-Apex properties and to the treatment of old tailings from the Park City region. Nearly all (438,145 tons) of the lead-zinc material was treated at flotation plants; 381 tons of ore were shipped to an eastern zinc plant and 26 tons to a plant on the Pacific coast. Nearly 73 percent of the total was treated at the Midvale mill and nearly all the remainder at the Silver King Coalition and Combined Metals mills. More than 60 percent of the total came from two properties (United States & Lark and Niagara) in the West Mountain district operated by the United States Smelting, Refining & Mining Co., and most of the remainder came from the Park City region. The United States & Lark property at Bingham was, as usual, the largest producer of lead-zinc ore in Utah, followed by the Silver King Coalition mine. The West Calumet, Hidden Treasure, and Ophir Hill Consolidated properties, all in the Ophir-Rush Valley section of Tooele County, also produced considerable lead-zinc ore.

Ore, old tailings, etc., sold or treated in Utah in 1934, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Beaver	5	2.08	3	13		
Box Elder	58	58.96	55		1,804	
Garfield	2	1.79				
Iron	2,757	1,228.60	9,634			
Juab	26,202	6,161.36	86,832	244,434	86,350	
Millard	130	35.42	158	912		
Piute	11,293	3,152.41	14,217	3,062	8,339	
Salt Lake	79,089	15,294.37	197,848	1,807,647	694,144	
Tooele	[1] 175,917	8,906.92	990	5,035	1,519	
Utah	65,380	27,177.43	333,367	518,119	985,900	
Wasatch	225	52.87	891		1,244	
Washington	3	41.80	20			
	361,061	62,114.01	644,015	2,579,222	1,779,300	
Total, 1933	139,473	47,658.11	485,315	1,475,651	630,504	

DRY GOLD AND SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Juab	15,336	2,420.55	121,292	135,706	133,448	
Salt Lake	38,840	3,390.60	132,205	580,141	423,051	
Sevier	64	26.90	1,666			
Summit	2,027	159.25	10,456	1,082	2,941	
Tooele	25	1.40	131	888		
Utah	4,023	742.64	32,310	28,228	99,444	
	60,315	6,741.34	298,060	746,045	658,884	
Total, 1933	2,687	535.64	40,122	30,397	41,071	

DRY SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Beaver	274	12.58	6,807			
Box Elder	111	18.17	14,321	388	568	
Iron	85	3.10	1,706			
Juab	18,568	1,121.49	312,998	123,637	963,334	
Piute	30	.07	551	694	626	
Salt Lake	12,290	472.35	88,052	329,022	441,039	
Summit	6,145	331.37	47,722	9,693	61,666	
Tooele	926	24.28	17,964	1,668	4,105	
Utah	18.314	1,210.07	527,649	192,585	890,106	
	56,743	3,193.48	1,017,770	657,687	2,361,444	
Total, 1933	7,847	527.53	376,858	88,269	426,754	

[1] Includes 170,512 tons of old tailings treated by cyanidation.

Ore, old tailings, etc., sold or treated in Utah in 1934, by counties, with content in terms of recovered metals—Continued

COPPER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Beaver	29	0.70	79	3,630	221	
Box Elder	19	3.06	23	800		
Garfield	2	2.53	3	250		
Juab	322	85.44	620	27,340		
Salt Lake	[2] 4,091,838	44,070.98	373,599	[3] 79,039,082	2,624	
Tooele	85	7.00	800	14,190	1,241	
Uintah	8		13	5,346		
	4,092,303	44,169.71	375,137	[3] 79,090,638	4,086	
Total, 1933	3,524,073	35,527.84	353,154	[4] 69,672,596	26,663	

LEAD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Beaver	15	0.52	439	70	6,049	
Box Elder	32	1.70	366	75	13,141	
Juab	[5] 4,110	215.04	74,943	5,195	1,365,117	
Piute	8	1.60	487	69	3,251	
Salt Lake	[6] 17,193	2,577.53	150,481	168,278	4,702,662	
Summit	[7] 414	26.44	20,455	9,112	139,365	
Tooele	28,780	1,307.99	230,397	252,947	10,755,320	
Uintah	15	.34	38	191	7,108	
Utah	16,421	723.67	520,565	112,675	7,014,567	
Wasatch	646	125.01	8,027	5,953	146,427	
	67,634	4,979.84	1,006,198	554,565	24,153,007	
Total, 1933	62,319	3,500.00	1,159,767	268,778	26,784,446	

COPPER-LEAD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Salt Lake	[8] 101	2.29	5,203	16,256	21,499	
Tooele	26	.95	415	1,115	5,040	
	127	3.24	5,618	17,371	26,539	
Total, 1933	(9)					

LEAD-ZINC ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Beaver	26	5.35	676	800	10,378	10,233
Juab	86	1.41	253		6,805	17,488
Salt Lake	267,768	11,746.79	1,743,891	1,686,574	59,221,062	33,405,628
Summit	[10] 113,537	2,055.33	1,458,051	484,613	23,959,812	18,844,140
Tooele	19,128	530.52	111,781	162,120	3,556,613	3,556,256
Utah	98	2.04	502	368	7,172	21,581
Wasatch	37,909	910.42	449,448	44,922	408,843	540,953
	438,552	15,251.86	3,764,602	2,379,397	87,170,685	56,396,279
Total, 1933	380,489	21,237.92	3,253,966	2,047,439	89,465,898	59,454,763

[2] Includes 4,983 tons of old mill cleanings and 1 ton of old matte sold to a smelter.
[3] Includes 2,453,490 pounds of copper saved from precipitates.
[4] Includes 4,107,381 pounds of copper saved from precipitates.
[5] Includes 36 tons of old slag sold to a smelter.
[6] Includes 2,392 tons of old slag sold to a smelter.
[7] Includes 3 tons of old tailings sold to a smelter.
[8] Includes 4 tons of old slag sold to a smelter.
[9] None produced in 1933.
[10] Includes 10,121 tons of old tailings reconcentrated.

Zinc products (as marketed from Utah mines and mills) sold to smelters and electrolytic plants in 1934

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of ore and concentrates	Recovered zinc
		Short tons	*Pounds*	*Percent*	*Pounds*
Oxidized lead-zinc ore	Salt Lake	381	202,056	26.52	171,744
Sulphide lead-zinc ore	Beaver	26	12,500	24.04	10,233
Zinc concentrates	Juab, Salt Lake, Summit, Tooele, Utah, and Wasatch.	56,951	63,178,719	55.47	56,214,302
		57,358	63,393,275	55.26	56,396,279
Total, 1933		58,811	66,088,373	56.19	59,489,193

METALLURGIC INDUSTRY

Of the 5,076,735 tons of ore, old tailings, etc., produced in Utah in 1934, 179,935 tons (3.54 percent), chiefly old tailings treated by cyanidation, were treated at gold and silver mills; 4,526,897 tons (89.17 percent), chiefly copper ore, were treated at concentration plants; and 369,903 tons (7.29 percent), chiefly siliceous ores, were shipped to smelters.

The Magna mill of the Utah Copper Co. was operated throughout the year and treated the greater part of the ore of milling grade. Two custom mills treating lead-zinc ore, at Midvale and Bauer, were active during 1934; the Silver King Coalition flotation mill, treating similar material at Park City, was run regularly. The largest active gold mill in Utah was the Manning cyanidation plant near Mercur, which was in continuous operation. The smelting plants at Murray, Midvale, Garfield, and International were active in 1934, but operations were greatly curtailed as in 1933; the Murray plant was active only during the fourth quarter of the year. The lead refinery of the United States Smelting, Refining & Mining Co. at Midvale was operated continuously in 1934 but closed early in 1935.

Five gold and silver mills were in operation in Utah in 1934—1 using straight amalgamation, 1 amalgamation and cyanidation, 1 straight cyanidation (treating old tailings), and 2 combined amalgamation or cyanidation and concentration. These 5 plants treated 9,423 tons of crude ore and 170,512 tons of old tailings. The following table gives data for operations at gold and silver mills in 1934.

Mine production of metals from gold and silver mills in Utah in 1934, by counties, in terms of recovered metals

County	Ore and old tailings treated (dry weight)		Recovered in bullion				Concentrates and recovered metal			
			Amalgamation		Cyanidation		Concentrates produced	Gold	Silver	Lead
	Ore	Old tailings	Gold	Silver	Gold	Silver				
	Short tons	*Short tons*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*
Garfield	2		1.79							
Iron	60		7.30	4	8.70	6				
Piute	9,361		715.88	547	119.00	240	35	669.69	3,441	
Tooele		170,512			7,006.94	107				
	9,423	170,512	724.97	551	7,134.64	353	35	669.69	3,441	
Total, 1933	3,597	24,709	143.27	79	1,769.70	20	22	134.55	363	78

Eight concentrating mills were active in Utah in 1934—6 using straight flotation and 2 using straight gravity. The increase in material treated (4,526,897 tons in 1934 compared with 3,902,263 tons in 1933) was chiefly in copper ore and lead-zinc ore. The following tables present ore-concentration data for 1934.

Utah ore and old tailings concentrated in 1934, by classes of ore and old tailings, methods of concentration, and classes of concentrates

Class of material concentrated	Method of concentration	Ore and old tailings concentrated	Gross content of mill feed				
			Gold	Silver	Copper	Lead	Zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Siliceous gold ore	Flotation	[1] 1,202	338.00	3,864			
Copper sulphide ore	do	4,086,800	51,820.62	431,975	83,501,498		
Lead-zinc sulphide ore and old tailings	do	[2] 438,145	18,491.91	4,101,142	3,593,360	96,698,078	83,525,735
		[1 2] 4,526,147	70,650.53	4,536,981	87,094,858	96,698,078	83,525,735
Lead sulphide ore	Gravity	[1] 750	7.86	2,450	1,407	154,128	
		[3] 4,526,897	70,658.39	4,539,431	87,096,265	96,852,206	83,525,735

Class of material concentrated	Method of contration	Concentrates produced		Gross content of concentrates				
		Class	Quantity	Gold	Silver	Copper	Lead	Zinc
			Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Siliceous gold ore	Flotation	Siliceous gold	[4] 22	318.82	3,167			
Copper sulphide ore	do	Copper sulphide	117,958	37,451.67	366,260	77,595,132		
Lead-zinc sulphide ore and old tailings	do	Lead sulphide	[5] 78,488	8,796.84	3,321,632	2,329,040	85,507,768	
		Zinc sulphide	[6] 56,951	1,727.97	309,818	542,013	4,331,808	63,178,719
		Siliceous	63,061	4,721.70	132,476	278,744	2,006,485	
			[5 6] 198,500	15,246.51	3,763,926	3,149,797	91,846,061	63,178,719
			316,480	53,017.00	4,133,353	80,744,929	91,846,061	63,178,719
Lead sulphide ore	Gravity	Lead sulphide	[4] 187	6.27	1,959	1,122	123,291	
			[7] 316,667	53,023.27	4,135,312	80,746,051	91,969,352	63,178,719

[1] 2 tons of ore treated by gravity and containing 3.00 ounces of gold and 4 ounces of silver included under straight flotation.
[2] Includes 10,121 tons of old tailings containing 12.89 ounces of gold, 13,575 ounces of silver, 6,806 pounds of copper, 151,600 pounds of lead, and 295,239 pounds of zinc.
[3] Figures do not include 9,361 tons of gold ore treated at gold and silver mills.
[4] 1 ton of concentrates from ore treated by gravity included under straight flotation.
[5] Includes 20 tons of lead concentrates from old tailings.
[6] Includes 48 tons of zinc concentrates from old tailings.
[7] Figures do not include 35 tons of gold concentrates from ore treated at gold and silver mills.

Mine production of metals from concentrating mills in Utah in 1934, by counties, in terms of recovered metals

County	Ore and old tailings treated		Concentrates and recovered metal					
	Ore	Old tailings	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Short tons*	*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Iron	1,200	--------	21	316.18	3,164	----------	----------	----------
Juab	88	--------	27	4.05	256	----------	6,805	17,488
Salt Lake	4,354,187	--------	271,149	49,198.46	2,110,151	76,953,852	59,104,402	33,233,884
Summit	103,416	10,121	36,035	2,055.33	1,458,051	484,613	23,959,812	18,844,140
Tooele	19,878	--------	8,421	536.79	113,740	163,079	3,674,965	3,556,256
Utah	98	--------	30	2.04	502	368	7,172	21,581
Wasatch	37,909	--------	984	910.42	449,448	44,922	408,843	540,953
	4,516,776	10,121	316,667	53,023.27	4,135,312	77,646,834	87,161,999	56,214,302
Total, 1933	3,902,263	--------	294,521	56,131.41	3,569,822	67,352,065	89,407,068	59,131,243

Gross metal content of Utah concentrates produced in 1934, by classes of concentrate

Class of concentrates	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	63,118	5,710.21	139,084	278,744	2,006,485	----------
Copper	117,958	37,451.67	366,260	77,595,132	----------	----------
Lead	78,675	8,803.11	3,323,591	2,330,162	85,631,059	----------
Zinc	56,951	1,727.97	309,818	542,013	4,331,808	63,178,719
	316,702	53,692.96	4,138,753	80,746,051	91,969,352	63,178,719
Total, 1933	294,543	56,265.96	3,570,185	69,908,279	94,208,025	65,669,611

Mine production of metals from Utah concentrates in 1934, in terms of recovered metals

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Iron	21	316.18	3,164	----------	----------	----------
Juab	27	4.05	256	----------	6,805	17,488
Piute	35	669.69	3,441	----------	----------	----------
Salt Lake	271,149	49,198.46	2,110,151	76,953,852	59,104,402	33,233,884
Summit	36,035	2,055.33	1,458,051	484,613	23,959,812	18,844,140
Tooele	8,421	536.79	113,740	163,079	3,674,965	3,556,256
Utah	30	2.04	502	368	7,172	21,581
Wasatch	984	910.42	449,448	44,922	408,843	540,953
	316,702	53,692.96	4,138,753	77,646,834	87,161,999	56,214,302
Total, 1933	294,543	56,265.96	3,570,185	67,352,065	89,407,146	59,131,243

BY CLASSES OF CONCENTRATES

Dry and siliceous	63,118	5,710.21	139,084	270,380	1,113,855	----------
Copper	117,958	37,451.67	366,260	75,267,278	----------	----------
Lead	78,675	8,803.11	3,323,591	1,600,434	81,951,761	----------
Zinc	56,951	1,727.97	309,818	508,742	4,096,383	56,214,302

The quantity of crude ore of smelting grade from Utah mines increased from 179,595 tons in 1933 to 362,484 tons in 1934; most of the increase was in siliceous ores (from 121,522 tons in 1933 to 296,982 tons in 1934), but there was also a good increase in lead ore. The following tables give the contents of the crude ore smelted, by classes and by counties.

Gross metal content of Utah crude ore shipped to smelters in 1934, by classes of ore

Class of ore	Ore (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	296,982	63,200.71	1,952,333	4,132,896	8,530,470	
Copper	519	100.08	2,440	61,302	7,436	
Lead	64,453	4,967.46	1,002,198	717,883	25,030,589	
Copper-lead	123	3.14	5,565	19,324	32,324	
Lead-zinc	407	5.35	676	1,260	168,545	214,556
	362,484	68,276.74	2,963,212	4,932,665	33,769,364	214,556
Total, 1933	179,595	50,670.91	2,093,244	2,216,929	29,830,369	418,762

Mine production of metals from Utah crude ore shipped to smelters in 1934, in terms of recovered metals

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Beaver	349	21.23	8,004	4,513	16,648	10,233
Box Elder	220	81.89	14,765	1,263	15,513	
Garfield	2	2.53	3	250		
Iron	1,582	899.52	8,166			
Juab	64,500	9,995.89	596,206	536,312	2,542,838	
Millard	130	35.42	158	912		
Piute	1,970	1,649.51	11,027	3,825	12,216	
Salt Lake	145,552	21,737.73	573,150	2,903,887	6,334,253	171,744
Sevier	64	26.90	1,666			
Summit	8,583	516.96	78,556	19,833	203,140	
Tooele	34,497	3,235.33	248,631	274,884	10,648,873	
Uintah	23	.34	51	5,537	7,108	
Utah	104,138	29,853.81	1,413,891	851,607	8,990,017	
Wasatch	871	177.88	8,918	5,953	147,671	
Washington	3	41.80	20			
	362,484	68,276.74	2,963,212	4,608,776	28,918,277	181,977
Total, 1933	179,595	50,670.91	2,093,244	2,102,645	27,760,553	357,950

BY CLASSES OF ORE

	Ore	Gold	Silver	Copper	Lead	Zinc
Dry and siliceous	296,982	63,200.71	1,952,333	3,982,954	4,799,628	
Copper	519	100.08	2,440	58,972	4,086	
Lead	64,453	4,967.46	1,002,198	548,935	23,961,485	
Copper-lead	123	3.14	5,565	17,115	26,040	
Lead-zinc	407	5.35	676	800	127,038	181,977

The miscellaneous material produced in Utah in 1934, not included in the tables under "Metallurgic Industry", consisted of copper precipitates, 4,983 tons of old mill clean-up, 2,432 tons of old slag, 3 tons of old tailings, and 1 ton of old matte, all shipped to smelters.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1934, by counties and districts, in terms of recovered metals

County and district	Mines producing		Ore, old tailings, etc.	Gold			Silver			Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total	Lode	Placer	Total				
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Beaver County:													
Beaver Lake	1		9	1.06		1.06	71		71	13	4,378		$246
Bradshaw	1		272	11.53		11.53	6,519		6,519				4,617
Granite	1		3	.46		.46							16
Lincoln	1		26	5.35		5.35	676		676	800	10,378	10,233	1,512
Newton	2		3	2.03		2.03	289		289				258
Star and North Star	3		36	.80		.80	449		449	3,700	1,892		684
Box Elder County:													
Ashbrook	2		111	18.17		18.17	14,321		14,321	388	568		9,945
Crater Island	1		19	3.06		3.06	23		23	800			186
Lucin	1		22	.80		.80	328		328		11,459		664
Park Valley	3		61	59.46		59.46	62		62		2,351		2,205
Willard	1		7	.40		.40	31		31	75	1,135		82
Garfield County:													
Colorado River		1			1.23	1.23							43
Henry Mountains	3		4	4.32		4.32	3		3	250			173
Imperial		4			8.04	8.04							281
Grand County:													
Colorado River		4			8.64	8.64		3	3				304
Dolores River		3			10.93	10.93							382
La Sal		1			54.05	54.05		11	11				1,896
Miners Basin		2			2.86	2.86							100
Iron County: Stateline	8		2,842	1,231.70		1,231.70	11,340		11,340				50,379
Juab County:													
Detroit [1]	1		1,754	511.30		511.30	2,350		2,350	63,537			24,472
Fish Springs	4		48	.77		.77	4,840		4,840	12	36,838		4,520
North Tintic	1		1	.03		.03	34		34		459		40
Spring Creek	3		115	50.53		50.53	577		577	175	2,135		2,232
Tintic [2]	19		62,692	9,432.13		9,432.13	588,970		588,970	472,113	2,514,973	17,488	841,976
West Tintic	2		14	10.53		10.53	167		167	475	649		538
Millard County:													
Detroit [1]	2		128	31.76		31.76	158		158	912			1,285
Sawtooth Mountains	1	2	2	3.66	3.49	7.15							250
Piute County:													
Gold Mountain	2		9,947	2,431.27		2,431.27	8,093		8,093				90,205
Mount Baldy	2		1,081	529.73		529.73	3,974		3,974	1,362	1,595		21,251
Ohio	6		303	193.08		193.08	3,188		3,188	2,463	10,621		9,399

Salt Lake County:													
Big Cottonwood	4		1,115	35.02		35.02	19,800		19,800	20,787	457,595	171,744	40,003
Little Cottonwood	5		766	133.22		133.22	16,556		16,556	13,825	137,567	12,256	22,082
Smelter	4		2,419	12.39		12.39	1,932		1,932	6,600	70,946		4,835
West Mountain [3]	17	7	4,502,819	77,374.28	10.93	77,385.21	2,652,991	3	2,652,994	83,585,788	64,839,973	33,221,628	14,934,152
San Juan County:													
Blanding		1			1.23	1.23							43
Red Canyon		1			5.18	5.18							181
Sevier County: Henry	2		64	26.90		26.90	1,666		1,666				2,017
Summit County: Uintah	8		122,123	2,572.39		2,572.39	1,536,684		1,536,684	504,500	24,163,784	18,844,140	2,828,035
Tooele County:													
Blue Bell	1		1				28		28		622		41
Camp Floyd	6		174,616	8,414.51		8,414.51	651		651				294,508
Clifton	15		2,609	458.28		458.28	7,747		7,747	23,625	297,486		33,922
Columbia	1		4	1.09		1.09	133		133				124
Dugway	1		5	1.00		1.00							35
Erickson	1		4	.80		.80	73		73	25	460		94
Free Coinage	3		154	.97		.97	750		750	163	78,406		3,433
Lakeside	2		200	1.49		1.49	368		368	537	54,675		2,356
Ophir	12		11,411	133.65		133.65	119,343		119,343	310,400	2,698,811	1,839,116	285,592
Rush Valley	4		35,728	1,694.28		1,694.28	233,091		233,091	102,700	11,187,973	1,717,140	705,908
Silver Islet	1		10				229		229	200	1,351		214
Third Term	1		1	3.58		3.58							125
West Mountain [3]	1		99	26.12		26.12	3		3				915
Willow Springs	3		45	43.29		43.29	62		62	313	4,054		1,728
Uintah County:													
Carbonate	2		23	.34		.34	51		51	5,537	7,108		751
Green River		2			21.46	21.46							750
Utah County:													
American Fork	8		6,929	2,906.98		2,906.98	27,086		27,086	177,112	81,270	21,581	137,213
Silver Lake	1		1	.20		.20	54		54	25	568		65
Tintic [2]	11		97,306	26,948.67		26,948.67	1,387,253		1,387,253	674,838	8,915,351		2,222,521
Wasatch County:													
Blue Ledge	2		38,524	1,081.32		1,081.32	451,798		451,798	46,925	518,406	529,860	375,583
Snake Creek	1		256	6.98		6.98	6,568		6,568	3,950	38,108	11,093	6,693
Washington County: Bull Valley	2		3	41.80		41.80	20		20				1,474
Total Utah, 1934	190	28	5,076,735	136,453.48	128.04	136,581.52	7,111,400	17	7,111,417	86,024,925	116,153,945	56,396,279	22,975,534
1933	121	21	4,116,935	108,987.04	142.51	109,129.55	5,669,182	15	5,669,197	73,583,130	117,376,556	59,489,193	[4] 16,324,369

[1] Detroit district lies in both Juab and Millard Counties.
[2] Tintic district lies in both Juab and Utah Counties.
[3] West Mountain district lies in both Salt Lake and Tooele Counties.
[4] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

BEAVER COUNTY

Several cars of siliceous silver ore were shipped in 1934 to smelters from the Honey Boy mine 11 miles southeast of Milford in the Bradshaw district. Other producers in Beaver County were the Beaver Lake mine in the Beaver Lake district, the Oak Leaf claim in the Granite district, the Lincoln mine in the Lincoln district, the Sheep Rock and Rob Roy claims in the Newton district, and the Cedar Talisman and Wild Bill properties in the Star district.

BOX ELDER COUNTY

The old Vipont mine in the Ashbrook district, a large producer o silver ore from 1920 to 1924, was worked in 1934 by lessees who shipped 3 cars of high-grade siliceous silver ore. Other producers in Box Elder County in 1934 were the Apex mine in the Ashbrook district, the Copper Blossom claim in the Crater Island district, the Tecoma mine in the Lucin district, the Susannah and Raft River properties in the Park Valley district, and the Mathews claim in the Willard district.

GARFIELD COUNTY

Placer gold was recovered in 1934 from the Colorado River and Imperial districts; a small lot of copper ore from former operations at the Bromide mine was shipped to a smelter; and test lots of gold ore from the Crescent No. 1 property and a prospect were amalgamated.

GRAND COUNTY

The entire output of Grand County in 1934 was placer gold and silver from the Colorado River, Dolores River, La Sal, and Miners Basin districts; most of it came from the Big Six placer in the La Sal district.

IRON COUNTY

All the output of Iron County in 1934 came from the Stateline district northwest of Modena, chiefly from the Jenny and Gold Coin mines. The Superior Gold Mining Co. completed a new 50-ton milling plant at the Jenny property, treated several hundred tons of gold ore by flotation, and (in addition to the concentrates) shipped several hundred tons of crude gold ore to a smelter. The Big Dipper Mining Corporation worked the Gold Coin mine, shipped several hundred tons of gold ore to a smelter, and treated a little ore in a small experimental mill equipped for amalgamation and cyanidation. Other producers in the Stateline district in 1934 were the Cougar, Ophir, Wonder, Johnny, Utah Spur, and Ryan properties.

JUAB COUNTY

Detroit district.—The only producing mine in the Detroit district in Juab County in 1934 was the Ibex mine of the Utah Central Mines Co., controlled by the Engineers Exploration & Mining Co.; more than 1,700 tons of gold ore and copper ore were shipped to Garfield for smelting.

Fish Springs district.—Small lots of first-class lead ore containing considerable silver from the Emma, Galena, New Deal, and Utah properties were shipped to smelters in 1934.

Spring Creek district.—The output of the Spring Creek district in 1934 included 2 cars of gold ore of smelting grade from the Gold Bond property and 2 cars of silver ore from the New Premier property. A little gold ore from the Queen of Sheba mine was tested in a small concentration plant.

Tintic district.—As indicated in the following table, the output of gold, silver, and copper from mines in the Tintic district in 1934, including both Juab and Utah Counties, increased markedly over that in 1933, but the production of lead and zinc decreased. There was a decided decrease in output of gold, silver, and lead from mines in the Utah County section of the district but a marked increase in all metals except zinc in the Juab section. The mines in both sections of the Tintic district are reviewed here.

Mine production of gold, silver, copper, lead, and zinc in Tintic district, Juab and Utah Counties, Utah, 1933-34, and total, 1869-1934, in terms of recovered metals

	Mines producing	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc	Total value
1934		*Short tons*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Juab County	19	[1] 62, 692	9, 432. 13	588, 970	472, 113	2, 514, 973	17, 488	$841, 976
Utah County	11	97, 306	26, 948. 67	1, 387, 253	674, 838	8, 915, 351	----------	2, 222, 521
	30	159, 998	36, 380. 80	1, 976, 223	1, 146, 951	11, 430, 324	17, 488	3, 064, 497
Total, 1933	20	100, 445	35, 723. 87	1, 708, 119	855, 050	12, 865, 944	346, 522	[2] 2, 056, 261
Total, 1869-1934	--------	(3)	2, 228, 895. 16	231, 540, 158	220, 929, 174	1,683,458,823	32, 255, 416	343,544,997

[1] Includes 36 tons of old slag sold to a smelter.
[2] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).
[3] Figures not available.

NOTE.—Total dividends, 1869-1934, $56,129,575.

Mine production of gold, silver, copper, lead, and zinc in Tintic district, Juab and Utah Counties, Utah, in 1934, by classes of ore, in terms of recovered metals

Class of ore	Mines producing	Ore, etc.	Gold	Silver	Copper	Lead	Zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	28	139, 539	35, 461. 29	1, 386, 260	1, 030, 017	3, 113, 949	----------
Lead	13	[1] 20, 373	918. 10	589, 710	116, 934	8, 309, 570	----------
Lead-zinc	1	86	1. 41	253	------------	6, 805	17, 488
	[2] 30	159, 998	36, 380. 80	1, 976, 223	1, 146, 951	11, 430, 324	17, 488

[1] Includes 36 tons of old slag sold to a smelter.
[2] A mine producing more than one class of ore is counted but once in arriving at total for all classes.

Producing mines in the Juab County section of the Tintic district in 1934 included the Alaska, Centennial-Beck, Chief Consolidated, Dragon, Eagle & Blue Bell, Empire, Iron Blossom, Mammoth, Plutus, Shoebridge, Showers, Swansea, Tintic Drain Tunnel, Victor, Victoria, and Wendego mines and various old dumps.

The Mammoth Mining Co. continued operations at the Mammoth mine, the largest producer in Juab County, and shipped nearly 25,000 tons of crude ore to smelters. Most of the material was siliceous gold ore; about 1,000 tons was lead ore. Several hundred tons of low-grade gold and silver ore were shipped for smelting from old Mammoth dumps.

The Chief Consolidated (including the Chief No. 1, Eureka Hill, and Gemini mines) and Plutus properties were operated by the Chief Consolidated Mining Co., and the output was much larger than in 1933. The output in 1934 consisted of silver ore and lead ore of smelting grade from the Chief Consolidated and Plutus properties and a little lead-zinc ore from the Chief No. 1 mine. According to the annual report of the Chief Consolidated Mining Co. the total production from all mines operated by the company (including the Eureka Lilly and Apex Standard in the Utah County section of the Tintic district) amounted to 36,991 tons of ore, 5,705 ounces of gold, 351,841 ounces of silver, 62,578 pounds of copper, 1,096,158 pounds of lead, and 26,674 pounds of zinc. Total development at all properties was 5,917 feet, chiefly in drifting.

The United States Smelting, Refining & Mining Co. continued operations at the Centennial-Beck (including the Centennial Eureka and Bullion Beck & Champion groups), Eagle & Blue Bell, and Victoria properties. All the ore shipped was of smelting grade, and most of it was siliceous gold and silver ore. The output of each property was considerably greater than in 1933, especially that of gold and silver ore from the Centennial-Beck group. Operations at all mines were conducted on a leasing basis, and no permanent development was reported.

Nearly 3,600 tons of siliceous gold and silver ore from the Empire mine and 860 tons of siliceous ore from the Dragon property were shipped for smelting.

The remainder of the output from the Juab County section of the Tintic district comprised siliceous silver ore from the Tintic Drain Tunnel, Alaska, Iron Blossom, Showers, and Wendego mines; gold and silver ore from the Shoebridge and Victor properties; lead ore from the Showers and Swansea mines; lead slag from an old smelter dump; and a little gold ore and lead ore cleaned up from assay offices.

In the eastern section of the Tintic district (Utah County), the Apex Standard, East Tintic Consolidated, Eureka Lilly, Eureka Standard, May Day, North Lily, Sioux, Success & Beck Tunnel, Tintic Standard, Utah, and Yankee properties were productive in 1934.

The output of lead ore from the Tintic Standard mine was considerably less in 1934 than in 1933, but the output of siliceous silver ore was greater. According to the annual report of the Tintic Standard Mining Co. for 1934 the mine produced 15,813 tons of lead ore and 17,070 tons of siliceous silver ore (compared with 20,936 and 5,920 tons, respectively, in 1933); the combined metal contents of both classes of ore shipped in 1934 were 1,741.17 ounces of gold, 1,029,412 ounces of silver, 324,444 pounds of copper, and 8,595,513 pounds of lead, a decrease of 159,449 ounces in silver and 3,779,112 pounds in lead compared with 1933. The mine ranked third as a producer of silver in Utah in 1934 and fourth in lead. The consolidated net profit in 1934 was $427,794, and four dividends amounting to $547,826 were paid during the year. The company has paid $15,295,709 in dividends since 1917. Mine development in 1934 consisted of 3,128 feet of drifting and 148 feet of raising.

The property of the Eureka Standard Consolidated Mining Co., controlled by the Tintic Standard Mining Co., was operated continuously in 1934. According to the annual report for 1934 of the controlling company the Eureka Standard mine produced 38,743 tons of ore containing 19,060.05 ounces of gold, 283,437 ounces of silver, 349,025 pounds of copper, and 1,089,155 pounds of lead, a decrease of nearly 8,000 ounces in gold and 42,242 ounces in silver compared with 1933; the output of copper decreased slightly, but that of lead increased 318,932 pounds. The mine again ranked second as a producer of gold in Utah. Net operating profit was $124,637, and dividends paid in 1934 were $149,959; the total dividends paid since 1930 have been $779,787. Mine development in 1934 comprised 4,047 feet of drifting, 566 feet of raising, and 140 feet of shaft sinking.

According to the annual report of the Chief Consolidated Mining Co. the Eureka Lilly mine was worked continuously in 1934 and produced 17,205 tons of ore, 4,656 ounces of gold, 20,049 ounces of silver, and 41,030 pounds of lead, a marked increase compared with 1933. Most (17,037 tons) of the output in 1934 was siliceous gold ore, and the remainder was lead ore. Development during the year consisted of sinking the shaft from the 500- to the 1,300-foot level and 577 feet of drifting, raising, and sinking. The Apex Standard mine, owned and operated by the Chief Consolidated Mining Co., produced 1,059 tons of siliceous silver ore in 1934 yielding 83 ounces of gold and 11,060 ounces of silver. More than 1,600 feet of development were done during the year, chiefly in shaft sinking and drifting.

The North Lily Mining Co. resumed operations (on a leasing basis) at the North Lily mine in 1934 and shipped more than 3,400 tons of siliceous ore and lead ore; the property was idle in 1933.

The East Tintic Consolidated mine, adjoining the Eureka Standard mine and controlled by the Eureka Standard Consolidated Mining Co., produced 1,366 tons of siliceous gold and silver ore in 1934 containing 248.80 ounces of gold, 10,879 ounces of silver, 21,870 pounds of copper, and 40,741 pounds of lead. The mine is operated through the Eureka Standard shaft; 241 feet of drifting and 73 feet of raising were done in 1934.

The remainder of the output from the Utah County section of the Tintic district comprised 1,014 tons of siliceous ore from the May Day mine, 652 tons of siliceous ore from the Success & Beck Tunnel (Colorado Consolidated) property, 636 tons of siliceous ore from the Utah mine, 204 tons of siliceous ore and lead ore from the Yankee mine, and 133 tons of siliceous ore from the Sioux mine; all these mines were operated by lessees.

West Tintic district.—A small lot of rich gold ore from the Orient mine and a little copper ore and lead ore from the Paymaster & Iron Cap property were marketed in 1934.

MILLARD COUNTY

The output of Millard County in 1934 comprised chiefly 2 cars of low-grade gold ore from the Copper Head mine and 1 car of similar ore from the Lone Eagle (King Tut) property in the Detroit district. A little placer gold and a small lot of gold ore were marketed from claims in the Sawtooth district.

PIUTE COUNTY

Gold Mountain district.—The Annie Laurie Consolidated Gold Mines Co. operated the Annie Laurie group 13 miles northwest of Marysvale during 1934 and treated 9,351 tons of siliceous gold ore in the 30-ton combined amalgamation, cyanidation, and flotation mill; in addition to the bullion and concentrates produced in the mill, the company marketed 531 tons of gold ore of smelting grade. Nearly 2,400 ounces of gold and more than 8,000 ounces of silver were recovered from all products. The Sevier-Miller group adjoining the Annie Laurie property was operated by a lessee who treated a little gold ore in a small amalgamation-concentration plant and shipped 55 tons of gold ore to a smelter.

Mount Baldy district.—The old Deer Trail mine 6 miles southwest of Marysvale was operated by lessees in 1934 who shipped 1,079 tons of gold ore to the smelter at Garfield.

Ohio district.—Most of the output of the Ohio district in 1934 was siliceous gold ore of smelting grade from the Southern Utah Metals, Bully Boy & Webster, and Gold Strike properties; a little silver ore from the Bullion Canyon mine, silver-lead ore from the Tate claim, and gold ore from the Adair prospect were marketed also.

SALT LAKE COUNTY

Big and Little Cottonwood districts.—The following table gives the combined output from mines in the Big and Little Cottonwood districts.

Mine production of gold, silver, copper, lead, and zinc in Big Cottonwood and Little Cottonwood districts, Utah, 1933–34, and total, 1867–1934, in terms of recovered metals

Year	Mines producing	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1933	9	1,434	98.88	11,041	8,852	430,651	354,456	[1] $37,778
1934	9	1,881	168.24	36,356	34,612	595,162	184,000	62,085
Total, 1867–1934		610,829	27,954.16	16,513,740	15,889,313	233,196,425	1,324,123	33,455,758

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+per ounce).

Most of the output of the Big Cottonwood district in 1934 came from the property of the Cardiff Mining & Milling Co.; the company shipped more than 500 tons of oxidized lead ore and 2 cars of sulphide copper-lead ore to smelters near Salt Lake City and nearly 400 tons of oxidized lead-zinc ore to a smelter in the East. The remainder of the district output comprised silver-lead ore of smelting grade from the Prince of Wales and Maxfield mines and gold ore from the Last Chance property.

Most of the output of the Little Cottonwood district in 1934 was first-class oxidized lead ore from the Columbus-Flagstaff and Columbus Rexall properties and silver ore and lead ore from the Alta Champion mine. The remainder of the district output consisted of gold ore from the Clementine mine, lead-zinc milling ore from the Columbus-Flagstaff and Columbus Rexall properties, oxidized copper ore of smelting grade from the Columbus-Flagstaff group, and test lots of lead ore and gold ore from two prospects.

Bingham or West Mountain district.—The mine production of the West Mountain district is given in the following tables.

Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Salt Lake County, Utah, 1933–34, and total, 1865–1934, in terms of recovered metals

Year	Mines producing	Ore, etc.	Gold (lode and placer)	Silver (lode and placer)	Copper [1]	Lead	Zinc	Total value
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1933	22	[2] 3,833,509	61,972.34	1,993,116	[3] 71,636,173	66,059,434	41,296,403	[4] $11,044,967
1934	24	[5] 4,502,819	77,385.21	2,652,994	[6] 83,585,788	64,839,973	33,221,628	14,934,152
Total, 1865–1934	-------	(7)	3,120,299.98	92,503,755	[8] 2,267,869	[8] 1,155,840	499,984,923	1,004,468,671

[1] Includes copper saved from precipitates.
[2] Includes 14 tons of old mill cleanings sold to a smelter.
[3] Includes 4,107,381 pounds of copper saved from precipitates.
[4] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+per ounce).
[5] Includes 4,983 tons of old mill cleanings sold to a smelter.
[6] Includes 2,453,490 pounds of copper saved from precipitates.
[7] Figures not available.
[8] Short tons.

NOTE.—Total dividends, 1865–1934, $242,889,503 (exclusive of dividends paid by United States Smelting, Refining & Mining Co.). No dividends paid in 1932, 1933, or 1934.

Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Salt Lake County, Utah, in 1934, by classes of ore, in terms of recovered metals

Class of ore	Mines producing	Ore and old cleanings	Gold	Silver	Copper	Lead	Zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	18	130,006	19,103.69	416,331	2,713,901	1,556,132	----------
Copper	5	[1] 4,091,786	44,069.05	372,690	[2] 79,032,006	----------	----------
Lead	10	13,696	2,455.50	120,478	154,091	4,199,500	----------
Lead-zinc	6	267,331	11,746.04	1,743,492	1,685,790	59,084,341	33,221,628
	[3] 24	4,502,819	[4] 77,374.28	[5] 2,652,991	[2] 83,585,788	64,839,973	33,221,628

[1] Includes 4,983 tons of old mill cleanings sold to a smelter.
[2] Includes 2,453,490 pounds of copper saved from precipitates.
[3] A mine producing more than one class of ore is counted but once in arriving at total for all classes.
[4] Also 10.93 ounces of gold produced from placers.
[5] Also 3 ounces of silver produced from placers.

The Utah Copper Co. continued regular operations in 1934 at the large opencut copper mine at Bingham. The output of copper ore in 1934 was 4,086,800 tons compared with 3,521,425 tons in 1933, an increase of 16 percent. All the ore was treated by flotation in the Magna mill (the Arthur mill remaining idle). The ore contained 1.02 percent copper, and the mill recovery was 92.90 percent. The company also produced considerable copper from copper precipitates shipped from the plant at Copperton. In addition to the regular shipments of concentrates and precipitates the company shipped nearly 5,000 tons of clean-up from the Arthur and Magna plants, which yielded 6,556 ounces of gold and 5,245 ounces of silver. The total production of copper from all sources was 78,787,348 net pounds, and the gross revenue from the sale of all metals (including gold and silver) was $8,927,244; no dividends were paid in 1934. The company was by far the largest producer of copper and gold in Utah in 1934 and ranked fifth in output of silver. No annual report was published by the Utah Copper Co. for 1934, but the report of the Kennecott Copper Corporation gave the net income of the Utah Copper Co. for the year as $1,375,070 after deducting all charges. The underground or sulphide unit, now known as the "Boston Consolidated", owned by the Utah Copper Co. was operated under lease in 1934 by the American Smelting & Refining Co. The leasing company, after completing the new shaft from the Armstrong tunnel, shipped nearly 13,000 tons of gold-copper ore to Garfield for smelting.

The United States Smelting, Refining & Mining Co. continued to operate the United States & Lark and Niagara groups in 1934. Most (89 percent) of the output from the three properties was lead-zinc ore treated at the 1,000-ton flotation plant at Midvale. The total output of lead-zinc ore decreased about 4,000 tons from that in 1933. Production of silver and copper, however, was more than in 1933, as the output of ore of smelting grade (chiefly siliceous ore) increased considerably. The total output of ore of all classes increased 9 percent over that in 1933. Mine development during 1934 comprised 23,354 feet of drifting, 3,403 feet of raising, and 33,426 cubic feet of shaft sinking and cutting pockets at the United States & Lark group and 515 feet of drifting and 214 feet of raising at the Niagara property. The consolidated net profit from all operations (including properties in Alaska and Mexico as well as in Utah and other States) was $6,052,968 compared with $5,169,875 in 1933. Dividends paid in 1934 totaled $6,000,129. The United States & Lark group was the largest producer of silver, lead, and zinc in Utah in 1934; it ranked second in production of copper and third in that of gold.

The property of the Utah-Apex Mining Co. was reopened on a leasing basis in 1934, and about 43,000 tons of ore were marketed. Most (30,317 tons) of the output was siliceous gold and silver ore shipped to Garfield for smelting; the remainder comprised 7,299 tons of crude lead ore and 4,445 tons of gold ore shipped to smelters and 1,006 tons of lead-zinc ore shipped to Midvale for milling.

Lessees continued operations throughout the year at the Highland Boy & Yampa property of the Utah-Delaware Mining Co. and shipped 36,383 tons of siliceous gold ore and 1,508 tons of lead ore to smelters. Production of silver, copper, and lead was more than double that in 1933, and production of gold also increased decidedly.

A lessee continued shipments of siliceous gold ore from the upper levels of the Utah Metal & Tunnel property, and the American Smelting & Refining Co. undertook deep development from the new Armstrong tunnel shaft. The output in 1934 was 10,942 tons of siliceous gold ore and 154 tons of lead ore.

Other producers in the West Mountain district, Salt Lake County, in 1934 were the Bingham group of the Combined Metals Reduction Co. (siliceous gold ore, siliceous gold and silver ore, lead ore, and lead-zinc ore), the New England property of the Bingham Metals Co. (siliceous gold ore and lead ore), the Ohio Copper Co. (copper precipitates), the Montana-Bingham Consolidated Mining Co. (siliceous gold and silver ore, lead-zinc ore, and copper precipitates), the Bingham

Premier Mining Co. (siliceous gold ore), and several other small shippers of ore or precipitates. In addition, placer bullion valued at $384 was marketed from several small operations.

Smelter district.—The output in 1934 consisted of lead slag from old smelter dumps and ore cleaned up along the railroad tracks near the smelters.

SAN JUAN COUNTY

A small quantity of placer gold was marketed from two operations in San Juan County in 1934.

SEVIER COUNTY

Henry district.—Several cars of siliceous gold and silver ore of smelting grade were shipped in 1934 from the B. W. & H. and Antelope properties near Belknap.

SUMMIT AND WASATCH COUNTIES

PARK CITY REGION

Mine production of gold, silver, copper, lead, and zinc in Park City region, Summit and Wasatch Counties, Utah, 1933–34, and total, 1870–1934, in terms of recovered metals

Year	Mines producing	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc	Total value
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1933	2	101,547	2,329.93	1,678,486	731,060	23,113,098	16,592,736	[1] $2,245,891
1934	11	[2] 160,903	3,660.69	1,995,050	555,375	24,720,298	19,385,093	3,210,311
Total, 1870–1934	--------	(3)	403,099.44	207,529,835	57,068,462	2,066,447,236	402,880,944	297,881,506

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

[2] Includes 10,121 tons of old tailings reconcentrated and 3 tons sold to a smelter.

[3] Figures not available.

NOTE.—Total dividends, 1870–1934, $65,132,049.

Mine production of gold, silver, copper, lead, and zinc in Park City region, Summit and Wasatch Counties, Utah, in 1934, by classes of ore, in terms of recovered metals

Class of ore	Mines producing	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	4	8,397	543.49	59,069	10,775	65,851	----------
Lead	6	[1] 1,060	151.45	28,482	15,065	285,792	----------
Lead-zinc	6	[2] 151,446	2,965.75	1,907,499	529,535	24,368,655	19,385,093
	[3] 11	160,903	3,660.69	1,995,050	555,375	24,720,298	19,385,093

[1] Includes 3 tons of old tailings sold to a smelter.

[2] Includes 10,121 tons of old tailings reconcentrated.

[3] A mine producing more than one class of ore is counted but once in arriving at total for all classes.

The Silver King Coalition Mines Co. operated its property near Park City at about the same rate as in 1933. The mine produced 103,395 tons of lead-zinc milling ore and 365 tons of lead ore of smelting grade. The milling ore yielded 19,278 tons of lead concentrates and 16,678 tons of zinc concentrates. There were also marketed 3,111 tons of zinc concentrates from storage (produced in 1932). The total gross metal content of the crude ore and concentrates, including concentrates from storage, was 2,103.49 ounces of gold, 1,502,539 ounces of silver, 627,638 pounds of copper, 25,421,462 pounds of lead, and 24,767,963 pounds of zinc. Total development amounted to 23,130 feet. Net profit, after all charges were deducted, was $547,563. Dividends paid in 1934 were $488,187, and a dividend of $122,047 was paid January 2, 1935. In 1934 the mine ranked second in silver, lead, and zinc in Utah. The American Flag mine was operated in 1934 by the Park City Development Co.; 1,100 feet of development were done, and nearly 7,700 tons of siliceous ore, largely dump material, were shipped to Garfield for smelting. Lessees shipped 519 tons of hand-sorted dump ore from the Daly West mine, and a test lot of lead ore was shipped from the B. F. C. property.

The remainder of the output from Summit County comprised current and old tailings from the Silver King Coalition mill re-treated by flotation, old tailings and dump material sent to the Midvale mill, and 3 tons of old tailings smelted.

The Park City Consolidated Mining Co. was the chief producer in the Wasatch County section of the Park City region in 1934. The mine was reopened late in 1933, and shipments of ore to the flotation plant at Midvale were continuous in 1934. During the year the company shipped 37,857 tons of ore containing 1,095.08 ounces of gold, 493,768 ounces of silver, and considerable copper, lead, and zinc. The Park City Utah Mines Co. operated the Liberty group during 1934 through the Star of Utah tunnel and shipped nearly 700 tons of lead ore and gold ore for smelting.

The remainder of the output from Wasatch County comprised lead ore and lead-zinc ore from the New Quincy property.

TOOELE COUNTY

Camp Floyd (Mercur) district.—The Manning Gold Mining Co. increased the capacity of its cyanide plant in Manning Canyon near Mercur from about 500 to about 900 tons a day and re-treated 170,512 tons of old tailings during 1934; the gold recovered was more than four times that in 1933. The remainder of the output of the Camp Floyd district consisted of gold ore of smelting grade from the Consolidated Mercur, La Cigale, Herschel, Sacramento, and McKendrick properties.

Clifton (Gold Hill) district.—The Aurum Gold Mining Co. shipped about 600 tons of gold ore from the Cane Springs mine in 1934, and a lessee shipped 960 tons of lead ore from the Garrison mine. The remainder of the Clifton district output comprised siliceous gold ore from the Alvarado, Gold Spar, Midas, Monarch No. 2, and Rube properties; lead ore from the Climax, Clifton Gulch, Lucy L., Monocco, Dalmonega, and Success properties; copper ore from the Copperopolis and Monocco mines; and a little silver ore from the Gold Spar claim.

Free Coinage district.—Oxidized lead ore of smelting grade was shipped in 1934 from the Humdinger (Lead Ore Mining Co.) and Salt Lake & Mamie (Utah-Bunker Hill Mining Co.) properties and from a prospect.

Lakeside district.—Lead ore of smelting grade was shipped in 1934 from the Monarch mine and a prospect.

Ophir district.—The Hidden Treasure Mining & Development Co. resumed operations at the Hidden Treasure mine on a lease basis in 1934 and shipped more than 4,000 tons of high-grade lead-zinc ore to the flotation mill at Midvale; in addition to the milling ore 2 cars of lead ore were shipped for smelting. The Ophir Development Co. continued shipments from the Ophir Hill Consolidated mine in 1934; lead-zinc ore (2,594 tons) was shipped to the Combined Metals mill at Bauer and crude lead ore (3,352 tons) to the smelter at Tooele. The remainder of the Ophir district output comprised siliceous silver ore from the Chloride Point, Zella, Buffalo, Fisk Ophir, Lakes of Killarney, Ophir, and Croft properties; lead ore from the Wandering Jew and Queen of the Hills mines; and copper-lead ore from the Kearsarge Standard property.

Rush Valley district.—The output of lead ore from the Cyclone-Tip Top group by the Bluestone Lime & Quartzite Mining Co. was considerably less in 1934 than in 1933, but the company retained its position as the largest producer of lead ore of smelting grade in the State.

The Combined Metals Reduction Co. continued to operate both the Honerine and West Calumet groups in 1934. The output from the West Calumet group increased considerably; lead-zinc ore (more than 12,000 tons) was shipped to the flotation mill at Bauer and crude lead ore (nearly 2,900 tons) to the smelter at Tooele. The output from the Honerine group comprised a little lead-zinc ore treated at the Bauer lead-zinc flotation mill and several hundred tons of lead ore concentrated in the jig plant at Bauer. The lead-zinc flotation mill at Bauer operated continuously during the year, chiefly on ore from Pioche, Nev., but considerable custom ore also was treated.

The remainder of the production of the Rush Valley district in 1934 was oxidized lead ore of smelting grade from the Commodore group of the Utah Ophir Mines Co.

West Mountain district.—The West Mountain district lies almost wholly in Salt Lake County, but its established western boundary extends over the divide of the Oquirrh Mountains into Tooele County. The Bingham Star mine, in Tooele County near the head of Pine Canyon about one-half mile from the Salt Lake-Tooele County line, was reopened in 1934, and nearly 100 tons of siliceous gold ore were sent to Garfield for smelting.

Willow Springs district.—The output of the Willow Springs district in 1934 consisted of 38 tons of gold ore from the Eagle's Nest mine 25 miles from Gold Hill and a small lot of copper ore from the Nicholes prospect near Ibapah.

UINTAH COUNTY

Carbonate district.—A small lot of oxidized copper ore from the old Dyer mine and 1 car of oxidized lead ore from the Lead Bell property 25 miles north of Vernal were shipped crude for smelting.

Green River district.—Most of the placer output of Uintah County came from the Bell Boy property of the Rio Verde Mining & Metal Corporation 20 miles south of Vernal. A little placer gold was marketed from the Jensen & Green River group.

UTAH COUNTY

American Fork district.—The following table gives the production from mines in the American Fork district.

Mine production of gold, silver, copper, lead, and zinc in American Fork district, Utah, 1933–34, and total, 1870–1934, in terms of recovered metals

Year	Mines producing	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
1933	3	7,169	2,497.31	22,509	195,024	185,117	----------	[1] $91,039
1934	8	6,929	2,906.98	27,086	177,112	81,270	21,581	137,213
Total, 1870–1934	--------	140,953	42,464.28	2,176,184	2,194,459	32,511,043	335,507	5,210,868

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

A lessee continued operations at the Live Yankee property of the American Smelting & Refining Co. and shipped in 1934 more than 6,700 tons of gold-copper ore to Garfield for smelting. Other producers in the district included the Globe mine, which yielded lead-zinc ore treated at the Midvale mill, and the Milkmaid, Miller, Hobnail, Silver Dipper, and Pacific properties, all of which yielded lead ore of smelting grade.

Tintic district.—The mines in the Utah County section of the Tintic district are reviewed under Juab County.

WASHINGTON COUNTY

Bull Valley district.—Small lots of gold ore were produced in 1934 at the Bull Run property and at a prospect in the Bull Valley district south of Enterprise.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN WASHINGTON

(MINE REPORT)

By C. N. Gerry and T. H. Miller [1]

SUMMARY OUTLINE

The output of gold, silver, copper, lead, and zinc from Washington ores and gravels in 1934, in terms of recovered metals, was 8,301.83 fine ounces of gold, 44,120 fine ounces of silver, 13,900 pounds of copper, 581,298 pounds of lead, and 3,852,419 pounds of zinc. This output compares with a production in 1933 of 4,562.68 ounces of gold, 18,520 ounces of silver, 5,781 pounds of copper, 1,680,430 pounds of lead, and 6,738,169 pounds of zinc. There were 62 lode mines and 210 placers producing in 1934 compared with 37 lode mines and 70 placers in 1933.

Since 1860 Washington has yielded an output of the five metals as follows: Gold, 1,492,551 fine ounces; silver, 9,387,142 fine ounces; copper, 27,082,796 pounds; lead, 70,085,027 pounds; and zinc, 40,708,951 pounds. The total value has amounted to $49,305,249.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly United States Government prices.[2] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

[1] Assisted by Paul Luff and LaRu Shepherd.

[2] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

Mine production of gold, silver, copper, lead, and zinc in Washington, 1930–34, in terms of recovered metals

Year	Mines producing: Lode	Mines producing: Placer	Ore, old tailings, etc. (short tons)	Gold (lode and placer): Fine ounces	Gold (lode and placer): Value	Silver (lode and placer): Fine ounces	Silver (lode and placer): Value
1930	24	14	45,456	4,244.81	$87,748	32,816	$12,634
1931	24	21	92,049	2,904.19	60,035	22,410	6,499
1932	40	55	42,272	5,082.13	105,057	17,412	4,910
1933	37	70	53,984	4,562.68	[1] 116,622	18,520	6,482
1934	62	210	47,902	8,301.83	290,149	44,120	28,522

Year	Copper: Pounds	Copper: Value	Lead: Pounds	Lead: Value	Zinc: Pounds	Zinc: Value	Total value
1930	1,206,438	$156,837	1,152,585	$57,629	703,782	$33,782	$348,630
1931	202,503	18,428	2,771,116	102,531	9,947,495	378,005	565,498
1932	5,524	348	1,842,267	55,268	4,489,334	134,680	300,263
1933	5,781	370	1,680,430	62,176	6,738,169	283,003	[1] 468,653
1934	13,900	1,112	581,298	21,508	3,852,419	165,654	506,945

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold and silver produced at placer mines in Washington, 1930–34, in fine ounces, in terms of recovered metals

Year	Gold	Silver	Year	Gold	Silver
1930	190.90	43	1933	990.96	166
1931	153.06	12	1934	1,773.45	317
1932	386.95	75			

Gold.—Production of gold in Washington increased about 3,739 ounces (82 percent) from 1933 to 1934. This large relative gain was due chiefly to regular shipments of gold ore from the First Thought mine in Stevens County near Orient and to increased shipments of gold ore from mines at Republic in Ferry County; the output of gold from placers increased about 780 ounces. Gold ore, old tailings, etc., yielded 78 percent of the State total and placers 21 percent. Mines in the Republic district, Ferry County, produced nearly 4,400 ounces of gold, chiefly from gold ore shipped to smelters, and lode and placer mines in Stevens County yielded most of the remainder. The Knob Hill mine at Republic was the largest producer of gold in Washington in 1934, followed closely by the First Thought mine at Orient; other large producers were the Blaine-Republic, Mountain Lion, and Old Gold properties, all at Republic. Crude ore of smelting grade yielded nearly 6,268 ounces of gold and placers about 1,773 ounces.

Silver.—Most of the increase of 25,600 ounces in production of silver in Washington in 1934 came from siliceous gold ore from mines at Republic in Ferry County and from siliceous silver ore and lead ore from mines in Stevens County. Gold ore and old tailings yielded 54 percent of the State total, silver ore 23 percent, and lead ore nearly 17 percent. The Knob Hill mine at Republic was the largest producer of silver in Washington in 1934, followed by the Old Dominion mine near Colville and the Daisy mine near Daisy, both in Stevens County, and the Blaine-Republic and Mountain Lion properties at Republic. Crude ore of smelting grade yielded 35,542 ounces of silver and concentrates of all classes 7,990 ounces.

Copper.—No copper ore was produced in Washington in 1934; nearly 80 percent of the copper came from siliceous ore and most of the remainder from lead-zinc ore.

Lead.—The output of recoverable lead in Washington was 1,099,132 pounds less in 1934 than in 1933, due chiefly to the closing of the mill of the Pend Oreille Mines & Metals Co. at Metaline Falls in April; decreases in lead output also were reported from mines in the Northport district. Lead-zinc ore of milling grade yielded more than 81 percent of the total lead and lead ore of smelting grade most of the remainder. The Josephine mine at Metaline Falls was, as usual, the largest producer of lead in Washington, followed by the Electric Point and Gladstone Mountain mines at Northport; these three properties produced nearly 95 percent of the State total.

Zinc.—The output of recoverable zinc in Washington in 1934, all of which came from lead-zinc milling ore from the Josephine mine of the Pend Oreille Mines & Metals Co., decreased nearly 43 percent compared with 1933, as the mill at Metaline Falls was closed in April.

MINE PRODUCTION BY COUNTIES

Mine production of gold, silver, copper, lead, and zinc in Washington in 1934, by counties, in terms of recovered metals

County	Mines producing			Ore, old tailings, etc.	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total	Short tons	Fine ounces	Value	Fine ounces	Value
Asotin		41	41		127.81	$4,467	17	$11
Benton		5	5		37.45	1,309	6	4
Chelan	5	23	28	49	86.72	3,031	25	16
Clallam		4	4		24.52	857	3	2
Columbia		1	1		3.15	110		
Douglas		3	3		5.35	187		
Ferry	21	15	36	11,713	4,620.63	161,491	24,114	15,589
Grant		2	2		4.29	150		
Grays Harbor		7	7		24.55	858	3	2
King	1	4	5	5	10.33	361	116	75
Kittitas	3	20	23	152	215.11	7,518	76	49
Lincoln		4	4		243.32	8,504	34	22
Okanogan	12	29	41	396	394.42	13,785	568	367
Pend Oreille	1	5	6	28,322	12.53	438	1,151	744
Skamania	1	2	3	1	8.30	290		
Snohomish	1	11	12	10	50.27	1,757	17	11
Stevens	13	27	40	7,170	2,376.25	83,050	17,871	11,553
Walla Walla		2	2		6.78	237		
Whatcom	4		4	84	28.93	1,011	116	75
Whitman		2	2		8.04	281		
Yakima		3	3		13.08	457	3	2
	62	210	272	47,902	8,301.83	290,149	44,120	28,522
Total, 1933	37	70	107	53,984	4,562.68	[1] 116,622	18,520	6,482

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Asotin							$4,478
Benton							1,313
Chelan							3,047
Clallam							859
Columbia							110
Douglas							187
Ferry	8,563	$685	3,784	$140			177,905
Grant							150
Grays Harbor							860
King	75	6	703	26			468
Kittitas							7,567
Lincoln							8,526
Okanogan	187	15	540	20			14,187
Pend Oreille	2,575	206	473,649	17,525	3,852,419	$165,654	184,567
Skamania							290
Snohomish	50	4					1,772
Stevens	2,450	196	102,189	3,781			98,580
Walla Walla							237
Whatcom			433	16			1,102
Whitman							281
Yakima							459
	13,900	1,112	581,298	21,508	3,852,419	165,654	506,945
Total, 1933	5,781	370	1,680,430	62,176	6,738,169	283,003	[1] 468,653

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+per ounce).

MINING INDUSTRY

The closing in April 1934 of the Josephine mill of the Pend Oreille Mines & Metals Co. caused a marked decrease in production of lead and zinc in Washington in 1934. Gold output, however, increased, chiefly at lode mines in the Republic and Orient districts and at placer mines along the Columbia River in Stevens County. The State output of placer gold in 1934 was about 1,773 ounces. The number of mines producing siliceous gold ore increased from 30 in 1933 to 42 in 1934. Several new or reconditioned milling plants were placed in operation at mines producing gold ore and silver ore. Of especial interest to the mining industry in Washington was the development program undertaken by the American Smelting & Refining Co. at the property of the Azurite Gold Co. in Whatcom County.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in Washington in 1934, with content in terms of recovered metals

Source	Mines producing	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
		Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry gold ore	42	[1] 17,456	6,487.17	23,988	8,600	1,216	
Dry gold and silver ore	3	66	19.22	1,183		249	
Dry silver ore	10	1,898	8.54	10,087	2,326	12,092	
	55	19,420	6,514.93	35,258	10,926	13,557	
Lead ore	6	160	13.45	7,394	399	94,092	
Lead-zinc ore	1	28,322		1,151	2,575	473,649	3,852,419
	7	28,482	13.45	8,545	2,974	567,741	3,852,419
Total, lode mines	62	47,902	6,528.38	43,803	13,900	581,298	3,852,419
Total, placers	210		1,773.45	317			
	272	47,902	8,301.83	44,120	13,900	581,298	3,852,419
Total, 1933	107	53,984	4,562.68	18,520	5,781	1,680,430	6,738,169

[1] Includes 1,150 tons of old tailings treated by cyanidation and 1 ton of old mill cleanings treated by amalgamation.

Value of metals from ore, old tailings, etc., sold or treated in Washington in 1934, by classes of ore

Class	Ore, old tailings, etc. (short tons)	Gold	Silver	Copper	Lead	Zinc	Total value
Dry gold ore	17,456	$226,727	$15,507	$688	$45		$242,967
Dry gold and silver ore	66	672	765		9		1,446
Dry silver ore	1,898	298	6,521	186	447		7,452
Lead ore	160	470	4,780	32	3,482		8,764
Lead-zinc ore	28,322		744	206	17,525	$165,654	184,129
	47,902	228,167	28,317	1,112	21,508	165,654	444,758
Total, 1933	53,984	[1] 91,293	6,424	370	62,176	283,003	[1] 443,266

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Gold ore.—The output of gold ore, old tailings, etc., increased from 5,261 tons in 1933 to 17,456 tons in 1934 as a result of the reopening of the First Thought mine at Orient and the large increase in output of gold ore from mines at Republic. The total material in 1934 comprised 15,863 tons of crude ore smelted, 1,150 tons of old tailings and 50 tons of ore treated by cyanidation, 230 tons of ore and 1 ton of clean-up material amalgamated, and 162 tons of ore concentrated.

More than 85 percent of the total came from the First Thought, Knob Hill, Blaine-Republic, Mountain Lion, and Lone Pine properties.

Gold and silver ore.—Three properties yielded 66 tons of gold and silver ore in 1934; none was produced in 1933. Nearly all the material in 1934 was first-class smelting ore.

Silver ore.—The output of 1,898 tons of silver ore in 1934 came chiefly from the Deer Trail and Daisy mines in Stevens County. Most (1,800 tons) of the ore was concentrated; the remainder was first-class smelting ore.

Lead ore.—All the lead ore produced in 1934 was of smelting grade, and most of it came from the Old Dominion, Electric Point, and Gladstone Mountain mines in Stevens County.

Lead-zinc ore.—In 1934, as in 1933, all the lead-zinc ore produced came from the Josephine mine at Metaline Falls and was concentrated. The output decreased from 48,479 tons in 1933 to 28,322 tons in 1934, as the Pend Oreille Mines & Metals Co. suspended operations in April. However, more than half the total ore, old tailings, etc., produced in the State in 1934 was lead-zinc ore.

Ore, old tailings, etc., sold or treated in Washington in 1934, by counties, with content in terms of recovered metals

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
DRY GOLD ORE						
Chelan	49	29.87	11			
Ferry	[1] 11,591	4,501.27	21,968	8,288		
Kittitas	152	115.28	48			
Okanogan	388	137.63	199	174	513	
Skamania	1	6.47				
Snohomish	10	7.15	11	50		
Stevens	5,183	1,661.34	1,692	88	270	
Whatcom	[2] 82	28.16	59		433	
	17,456	6,487.17	23,988	8,600	1,216	
Total, 1933	5,261	3,561.99	13,890	626	263	
DRY GOLD AND SILVER ORE						
Ferry	34	9.75	362		195	
Stevens	30	8.70	764		54	
Whatcom	2	.77	57			
	66	19.22	1,183		249	
Total, 1933	(3)					
DRY SILVER ORE						
Ferry	79	4.91	1,693	225	1,426	
Okanogan	8	.17	330	13	27	
Stevens	1,811	3.46	8,064	2,088	10,639	
	1,898	8.54	10,087	2,326	12,092	
Total, 1933	14	2.80	618		485	
LEAD ORE						
Ferry	9	0.06	74	50	2,163	
King	5	3.66	116	75	703	
Stevens	146	9.73	7,204	274	91,226	
	160	13.45	7,394	399	94,092	
Total, 1933	230	6.93	586	93	235,899	
LEAD-ZINC ORE						
Pend Oreille	28,322		1,151	2,575	473,649	3,852,419
	28,322		1,151	2,575	473,649	3,852,419
Total, 1933	48,479		3,260	5,062	1,443,783	6,738,169

[1] Includes 1,150 tons of old tailings treated by cyanidation.
[2] Includes 1 ton old mill cleanings treated by amalgamation.
[3] None produced in 1933.

Zinc products produced or marketed from Washington mines and mills in 1934

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of concentrates	Recovered zinc
		Short tons	*Pounds*	*Percent*	*Pounds*
Zinc concentrates	Pend Oreille	3,536	4,280,459	60.53	3,852,419
		3,536	4,280,459	60.53	3,852,419
Total, 1933		6,086	7,486,855	61.51	6,738,169

METALLURGIC INDUSTRY

The total output of ore, old tailings, etc., in Washington in 1934 was 47,902 tons, of which 1,431 tons were treated at gold and silver mills, 30,286 tons were treated at concentration plants, and 16,185 tons were shipped crude to smelters.

The material treated at gold and silver mills consisted of 230 tons of ore and 1 ton of clean-up material treated at 8 small amalgamation plants and 1,150 tons of old tailings and 50 tons of ore treated at 1 cyanidation plant.

Seven concentrating mills were active in 1934—3 flotation plants (1 treating lead-zinc ore, 1 silver ore, and 1 gold ore) and 4 gravity-concentration plants treating siliceous ore. Most (28,322 tons) of the material was lead-zinc ore treated by flotation. The following tables give the production of concentrates by classes and counties.

Gross metal content of Washington concentrates produced in 1934, by classes of concentrates

Class of concentrates	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Dry and siliceous	175	41.19	6,839	2,314	15,825	
Lead	374		800	600	482,286	
Zinc	3,536		351	2,650	13,309	4,280,459
	4,085	41.19	7,990	5,564	511,420	4,280,459
Total, 1933	7,172	18.53	3,294	6,468	1,511,543	7,486,855

Mine production of metals from Washington concentrates in 1934, in terms of recovered metals

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*
Okanogan	8	13.40	18	174	144	
Pend Oreille	3,910		1,151	2,575	473,649	3,852,419
Stevens	153	3.31	6,710	1,988	10,054	
Whatcom	14	24.48	111		433	
	4,085	41.19	7,990	4,737	484,280	3,852,419
Total, 1933	7,172	18.53	3,294	5,082	1,443,908	6,738,169

BY CLASSES OF CONCENTRATES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
Dry and siliceous	175	41.19	6,839	2,162	10,631	
Lead	374		800	450	462,995	
Zinc	3,536		351	2,125	10,654	3,852,419

The output of crude ore of smelting grade in 1934 increased 10,921 tons over that in 1933, due almost entirely to the large increase in production of gold ore from mines at Orient and Republic; about 98 percent of it was gold ore, most of which was shipped to the smelter at Trail, British Columbia.

Gross metal content of Washington crude ore shipped to smelters in 1934, by classes of ore

Class of ore	Quantity (dry weight)	Gross metal content			
		Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Dry and siliceous	16,025	6,254.26	28,148	9,086	3,567
Lead	160	13.45	7,394	509	98,353
	16,185	6,267.71	35,542	9,595	101,920
Total, 1933	5,264	3,246.29	14,887	792	247,384

Mine production of metals from Washington crude ore shipped to smelters in 1934, in terms of recovered metals

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead
	Short tons	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*
Ferry	10,513	4,465.99	23,897	8,563	3,784
King	5	3.66	116	75	703
Okanogan	287	110.99	504	13	396
Snohomish	10	7.15	11	50	
Stevens	5,370	1,679.92	11,014	462	92,135
	16,185	6,267.71	35,542	9,163	97,018
Total, 1933	5,264	3,246.29	14,887	699	236,522

BY CLASSES OF ORE

	Ore	Gold	Silver	Copper	Lead
Dry and siliceous	16,025	6,254.26	28,148	8,764	2,926
Lead	160	13.45	7,394	399	94,092

REVIEW BY COUNTIES AND DISTRICTS

Mine production of gold, silver, copper, lead, and zinc in Washington in 1934, by counties and districts, in terms of recovered metals

County and district	Mines producing		Ore, old tailings, etc.	Gold			Silver			Copper	Lead	Zinc	Total value
	Lode	Placer		Lode	Placer	Total	Lode	Placer	Total				
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	*Pounds*	
Asotin County: Snake River	-	41	-	-	127.81	127.81	-	17	17	-	-	-	$4,478
Benton County: Columbia River	-	5	-	-	37.45	37.45	-	6	6	-	-	-	1,313
Chelan County:													
Blewett	3	9	9	9.90	11.99	21.89	-	3	3	-	-	-	767
Columbia River	-	3	-	-	9.81	9.81	-	3	3	-	-	-	345
Entiat	2	-	40	19.97	-	19.97	11	-	11	-	-	-	705
Wenatchee River	-	11	-	-	35.05	35.05	-	8	8	-	-	-	1,230
Clallam County:													
Clallam Bay	-	1	-	-	3.69	3.69	-	-	-	-	-	-	129
Mora	-	1	-	-	.89	.89	-	-	-	-	-	-	31
Ozette	-	2	-	-	19.94	19.94	-	3	3	-	-	-	699
Columbia County: Snake River	-	1	-	-	3.15	3.15	-	-	-	-	-	-	110
Douglas County: Columbia River	-	3	-	-	5.35	5.35	-	-	-	-	-	-	187
Ferry County:													
Belcher	1	-	[1]	[1]	-	[1]	[1]	-	[1]	-	-	-	[1]
Columbia River	-	11	-	-	95.85	95.85	-	14	14	-	-	-	3,359
Danville	1	1	156	110.21	3.18	113.39	141	-	141	8,288	-	-	4,717
Deadman Creek	1	-	9	.06	-	.06	74	-	74	50	2,163	-	134
Enterprise	3	-	69	4.55	-	4.55	1,632	-	1,632	225	1,135	-	1,274
Republic	15	3	11,477	4,387.95	5.61	4,393.56	22,063	3	22,066	-	486	-	167,838
Grant County: Columbia River	-	2	-	-	4.29	4.29	-	-	-	-	-	-	150
Grays Harbor County: Ocean Beach	-	7	-	-	24.55	24.55	-	3	3	-	-	-	860
King County:													
Miller River	1	-	5	3.66	-	3.66	116	-	116	75	703	-	235
Tolt River	-	4	-	-	6.67	6.67	-	-	-	-	-	-	233
Kittitas County:													
Swauk	3	18	152	115.28	90.56	205.84	48	28	76	-	-	-	7,243
Yakima River	-	2	-	-	9.27	9.27	-	-	-	-	-	-	324
Lincoln County: Columbia River	-	4	-	-	243.32	243.32	-	34	34	-	-	-	8,526
Okanogan County:													
Cascade	2	-	131	49.99	-	49.99	62	-	62	-	-	-	1,787
Columbia River	-	11	-	-	42.43	42.43	-	8	8	-	-	-	1,488
Conconully	1	-	2	.06	-	.06	178	-	178	13	27	-	119
Myers Creek and Mary Ann Creek	2	7	150	64.15	68.47	132.62	57	11	68	-	-	-	4,679
Palmer Mountain	4	-	70	16.62	-	16.62	223	-	223	12	513	-	745
Similkameen River	-	10	-	-	145.18	145.18	-	20	20	-	-	-	5,087

Squaw Creek	2		13	2.17		2.17	6		6	37			83
State Creek		1			.54	.54							19
Upper Methow	1		(1)	(1)		(1)	(1)		(1)	(1)			(1)
Pend Oreille County: Metaline	1	5	28,322		12.53	12.53	1,151		1,151	2,575	473,649	3,852,419	184,567
Skamania County:													
Columbia River		1			.40	.40							14
Lewis River		1			1.43	1.43							50
Niggerhead	1		1	6.47		6.47							226
Snohomish County:													
Silver Creek	1		10	7.15		7.15	11		11	50			261
Skykomish River		3			2.95	2.95							103
Sultan		8			40.17	40.17		6	6				1,408
Stevens County:													
Aladdin	1		2				25		25	13	135		22
Columbia River		26			523.86	523.86		102	102				18,375
Colville	1		90	9.73		9.73	7,057		7,057	187	14,271		5,445
Kettle Falls	2		40	13.16		13.16	784		784	13	54		970
Northport	4	1	62		169.16	169.16	1,259	45	1,304	162	77,108		9,621
Orient	3		5,173	1,656.88		1,656.88	1,672		1,672	75	270		59,005
Springdale	1		1,203	.46		.46	2,274		2,274	100	1,189		1,538
Summit	1		(1)	(1)		(1)	(1)		(1)	(1)	(1)		(1)
Walla Walla County:													
Columbia River		1			3.86	3.86							135
Snake River		1			2.92	2.92							102
Whatcom County:													
Everson	1		2	.77		.77	57		57				64
Mount Baker	1		1	.89		.89							31
Slate Creek	2		81	27.27		27.27	59		59		433		1,007
Whitman County: Snake River		2			8.04	8.04							281
Yakima County:													
Columbia River		1			3.72	3.72							130
Summit		1			8.04	8.04		3	3				283
Yakima River		1			1.32	1.32							46
Undistributed [2]			632	21.03		21.03	4,843		4,843	2,025	9,162		4,367
Total Washington, 1934	62	210	47,902	6,528.38	1,773.45	8,301.83	43,803	317	44,120	13,900	581,298	3,852,419	506,945
1933	37	70	53,984	3,571.72	990.96	4,562.68	18,354	166	18,520	5,781	1,680,430	6,738,169	[3] 468,653

[1] Included under "Undistributed."
[2] Includes items entered as "(1)" above.
[3] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

ASOTIN COUNTY

The mine output of Asotin County in 1934 was all placer gold and silver recovered from the banks of Snake River. Most of the gold was sold to a bullion buyer in Clarkston.

BENTON COUNTY

Placer bullion was marketed in 1934 from properties on the Columbia River near Kennewick, Richland, and White Bluffs.

CHELAN COUNTY

Blewett and Peshastin district.—A little gold ore from the Diamond Dick, Pole Pick, and Wright properties was treated in 1934 by amalgamation, and placer bullion was marketed from operations on Peshastin Creek.

Columbia River and Wenatchee River districts.—Placer bullion was marketed in 1934 from various operations on the Columbia and Wenatchee Rivers in Chelan County.

Entiat district.—In 1934, as in 1933, the only producers in the Entiat district were the Rex and Sunshine mines near Entiat; a little gold ore from each mine was treated by amalgamation.

CLALLAM, COLUMBIA, AND DOUGLAS COUNTIES

Placer bullion was recovered in 1934 from beach sands at Clallam Bay, Mora, and Ozette in Clallam County; from bars on the Snake River in Columbia County; and from placer operations along the Columbia River near Orondo and Rock Island in Douglas County.

FERRY COUNTY

Belcher district.—A small lot of gold ore from the Oversight group was shipped in 1934 to a smelter.

Columbia River district.—Placer bullion was marketed in 1934 from properties on the Columbia River near Gerome. The largest producers were the Rogers Bar, Wilmott Bar, Fruitland, Long, and Big Ben & Baby Ben placers.

Danville district.—Four cars of gold ore of smelting grade containing considerable copper were shipped in 1934 from the Danville mine, and a little placer gold was recovered at the Singer property on Fourth of July Creek.

Enterprise (Covada, Meteor) district.—Siliceous silver ore of smelting grade was shipped in 1934 from the Big Silver, Florence, and Silver Leaf & Messinger properties 8 miles southwest of Inchelium. The mines in the Enterprise district had been idle for several years.

Republic district.—The value of the metal output from mines in the Republic district increased from $81,512 in 1933 to $167,838 in 1934, due to larger shipments of gold ore and the increase in price of gold. The Knob Hill mine was the largest producer in the district in 1934, followed by the Blaine-Republic, Mountain Lion, and Old Gold properties. Most of the district output was gold ore of smelting grade from the Knob Hill, Blaine-Republic, Mountain Lion, Old Gold, Last Chance, Lone Pine-Surprise, Blacktail, Tom Thumb, Little Cove, San Poil, El Caliph, Morning, and High Line properties;

the remainder of the lode mine output consisted of ore and old tailings from the Blaine-Republic property treated by cyanidation, 1 car of gold and silver ore from the Blue Horse mine, and a little silver ore from the Porcupine property. The placer output came from the Old Republic, Frank Thorpe, and Alva Stout properties. From 1896 to the end of 1934 the district produced 729,077 tons of ore and old tailings, 430,344.67 fine ounces of gold, 2,630,531 fine ounces of silver, and 722 pounds of lead, valued in all at $10,616,673.

GRANT, GRAYS HARBOR, AND KING COUNTIES

Placer bullion valued at $150 was recovered in 1934 from bars along the Columbia River in Grant County; gold and silver valued at $860 came from beach sands in Grays Harbor County; and $233 in gold was recovered from placer claims along the Tolt River in King County. A small lot of lead ore containing gold, silver, and copper was shipped from the Coney Basin property in the Miller River district, King County, to the smelter at Tacoma.

KITTITAS COUNTY

Swauk district.—High-grade gold ore from the Mountain Daisy, Sunrise, and Elk Horn mines was treated in 1934 by amalgamation. The placer output of the Swauk district was recovered chiefly from the Burcham, Sunny Bar, Dennett, and Discovery properties.

Yakima River district.—A little placer gold was recovered in 1934 from claims along the Yakima River.

LINCOLN COUNTY

The entire output of Lincoln County in 1934 was placer gold and silver recovered from claims on the Columbia River north of Wilbur, and nearly all of it came from the Clark Diggings where operations were in progress for 10 months. The placer bullion recovered from this property was valued at $8,243 and came from the treating of 19,700 yards of gravel.

OKANOGAN COUNTY

Cascade district.—Three cars of gold ore from the Bodie mine and 1 car from the Golden Axe mine were shipped in 1934 for smelting. A new 75-ton flotation plant was being constructed at the Bodie property late in the year.

Columbia River district.—Placer bullion was marketed in 1934 from several properties along the Columbia River near Pateros, Monse, and Kartar. The largest producers were the Gold Bar, Gove, Poyneer, and Chinaman's Friend properties.

Myers Creek and Mary Ann Creek district.—The Overtop Mining Co. shipped 3 cars of gold ore in 1934 from the Poland-China mine and treated a little ore in a small amalgamation plant; gold ore from the Gray Eagle mine also was treated by amalgamation. The placer output came chiefly from the Ottia May, Johnston, and Spoonamore properties on Mary Ann Creek.

Palmer Mountain district.—One car of gold ore from the Hiawatha & Josie mine and a little silver ore from the Ruby (Pyrargyrite) property were shipped in 1934 to smelters, and gold ore from the Spokane mine was treated in a small concentration plant.

Similkameen River district.—The entire output of the Similkameen River district in 1934 was placer bullion, recovered chiefly from the old Wasco, Olcott, and Vancouver properties along the Similkameen River near Oroville.

Squaw Creek district.—A little gold ore from the St. Anthony mine was treated in 1934 in a small concentration plant, and a small lot of gold ore from the Gold Coin mine was shipped to a smelter.

Upper Methow district.—A little gold ore from the Mountain Beaver mine was treated in 1934 in a new 10-ton flotation mill; the concentrates were shipped to the smelter at Kellogg, Idaho.

PEND OREILLE COUNTY

Metaline district (Metaline Falls).—The output of the Metaline district in 1934 consisted of lead-zinc milling ore from the Josephine property of the Pend Oreille Mines & Metals Co. and gold bullion from placer operations along the Pend Oreille River. The Pend Oreille Mines & Metals Co., which had resumed operations June 1, 1933, continued active until April 22, 1934. During 1934 the company treated 28,322 tons of lead-zinc ore in the 300-ton flotation plant and produced 374 tons of lead concentrates and 3,536 tons of zinc concentrates. The company has been the only producer of zinc in Washington since 1931 and the largest producer of lead since 1930. The output of lead-zinc ore was much less in 1934 than in 1933 when 48,479 tons were treated. This large decline caused a decided decrease in the value of the metal production of Pend Oreille County in 1934.

SKAMANIA COUNTY

A little placer gold from bars on the Columbia and Lewis Rivers and a little gold bullion from the Camp Creek Metals lode property were marketed in 1934.

SNOHOMISH COUNTY

Placer bullion valued at $1,408 was marketed in 1934 from operations along the Sultan River, and a little placer gold was recovered from the Shirley claim on the North Fork of Skykomish River. The Silver Creek Mining Co., owning a lode mine in the Silver Creek district, shipped a small lot of gold ore to a smelter.

STEVENS COUNTY

Columbia River district.—The output from placers along the Columbia River in Stevens County increased decidedly and accounted for most of the increase in gold from placer mines in Washington in 1934. The Nobles, Inc., placer near Evans was the largest producer, followed by the Blue Bar placer near Kettle Falls and the Brod-Hurst placer near Marcus. Other large producers were the Picnic Mining Co. near Marcus; the Anderson, McGrath, Pohle, Van Stone, and Weston placers near Northport; and the La Dow placer near Hunters.

Colville district.—A lessee in 1934 shipped 3 cars of lead ore containing considerable silver from the dump of the Old Dominion property near Colville.

Kettle Falls (Meyers Falls) district.—One car of siliceous gold and silver ore from the Gold Ledge mine and a little gold ore from the Lucky Strike mine were shipped in 1934 for smelting.

Northport district.—All the gold produced in the Northport district in 1934 came from the Nigger Creek placer operated by the Roberts Leasing Co.; virtually all the silver came from the Jackson (White Silver City) property; and nearly all the lead came from the Electric Point and Gladstone Mountain mines. Some of the ore from the Jackson property contained nearly 400 ounces of silver to the ton.

Orient district.—The First Thought mine near Orient, an important gold producer in 1934, was purchased in January 1934 by Russell Parker, and from May 7 to November 15 more than 5,000 tons of ore averaging about $10 a ton in gold were shipped to Trail, British Columbia, for smelting. Most of the material was shipped early in the year from old mine dumps, but late in the year the mine was reopened and unwatered for sampling. The property was the second largest producer of gold in Washington in 1934, and its production accounted for a large part of the increase in gold from lode mines. The remainder of the output of the Orient district was gold ore of smelting grade from the Gold Fisher & White Bear and Hidden Treasure mines.

Springdale district.—The Springdale district, an important silver camp in the past, was rejuvenated in 1934. The old mine dumps of the Deer Trail property were leased by the Perdiver Mining Corporation, which built a new 75-ton flotation plant and treated about 1,200 tons of siliceous silver ore during November and December. The concentrates, averaging 257 ounces of silver to the ton, were shipped to Kellogg, Idaho, for smelting.

Summit district.—The Consolidated Silver Mountain Mining Co. treated several hundred tons of silver ore from the Daisy-Tempest group in a 50-ton concentration plant in 1934; the concentrates were shipped to Tacoma for smelting.

WALLA WALLA COUNTY

Placer gold valued at $237 was recovered in 1934 from bars along the Columbia and Snake Rivers in Walla Walla County.

WHATCOM COUNTY

Slate Creek district.—Production in the Slate Creek district in 1934 consisted of 13 tons of gold concentrates shipped from former milling operations at the Mammoth property and a little gold bullion recovered in cleaning up old mill machinery at the Bonita mine of the New Light Gold Mining Co. The property of the Azurite Gold Co. was leased in January to the American Smelting & Refining Co., which undertook a large development program to place the property on a production basis. The mine has a substantial reserve of proven ore, but the inaccessibility of the property has delayed development and production.

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WHITMAN COUNTY

Placer gold valued at $281 was marketed in 1934 from bars along the Snake River in Whitman County, chiefly from the Indian Bar near Penawawa.

YAKIMA COUNTY

A little placer gold was marketed in 1934 from a claim on the Columbia River near Priest Rapids and from property on the Yakima River. The Gold Hill placer in the Summit district at the head of Morse Creek was worked by lessees who recovered about $283 in gold and silver.

GOLD, SILVER, COPPER, AND LEAD IN WYOMING

(MINE REPORT)

By Chas. W. Henderson

SUMMARY OUTLINE

Wyoming metal mines produced, in terms of recovered metals, 4,871.36 fine ounces of gold, 710 fine ounces of silver, 3,500 pounds of copper, and 2,000 pounds of lead in 1934 compared with 2,199.95 ounces of gold and 260 ounces of silver in 1933. Gold constituted 99.5 percent of the total value of the four metals in 1934 and came chiefly from the Atlantic City district, Fremont County. The number of producing lode mines increased from 4 in 1933 to 10 in 1934 and placers from 20 to 41.

The total recorded production of gold, silver, copper, and lead (in terms of recovered metals) in Wyoming from 1867 to 1934, inclusive, has been 67,836 fine ounces of gold, 71,501 fine ounces of silver, 32,637,059 pounds of copper, and 11,800 pounds of lead.

Calculation of value of metal production.—The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold in 1930–32 is figured at $20.671835 per ounce, the Treasury legal coinage value for fine gold from January 18, 1835, to January 31, 1934; in 1933 at $25.56 and in 1934 at $34.95 per ounce, the average weighted yearly U. S. Government prices.[1] The silver price in 1930–33 is the average New York price for bar silver; in 1934 the Treasury buying price for newly mined silver, $0.64646464+ per ounce. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

[1] The Treasury from February 1, 1934, through December 1934 has calculated all gold, old and new, at $35.00 per ounce, under authority of the Gold Reserve Act of January 31, 1934. Details of the U. S. Government fluctuating price of gold in 1933 to January 31, 1934, may be found in Minerals Yearbook, 1934, pp. 25–28.

Prices of gold, silver, copper, lead, and zinc, 1930–34

Year	Gold	Silver	Copper	Lead	Zinc
	Per fine ounce	*Per fine ounce*	*Per pound*	*Per pound*	*Per pound*
1930	[1] $20.67+	$0.385	$0.130	$0.050	$0.048
1931	[1] 20.67+	.290	.091	.037	.038
1932	[1] 20.67+	.282	.063	.030	.030
1933	25.56	.350	.064	.037	.042
1934	34.95	[2] .646+	.080	.037	.043

[1] $20.671835. [2] $0.64646464.

Mine production of gold, silver, copper, and lead in Wyoming, 1930–34, in terms of recovered metals

Year	Ore (short tons)	Gold (lode and placer)		Silver (lode and placer)		Copper		Lead		Total value
		Fine ounces	Value	Fine ounces	Value	Pounds	Value	Pounds	Value	
1930	1,285	443.02	$9,158	122	$47	11,600	$1,508	--------	--------	$10,713
1931	23	56.36	1,165	17	5	9,000	819	--------	--------	1,989
1932	640	256.63	5,305	195	55	397	25	9,800	$294	5,679
1933	1,071	2,199.95	[1] 56,231	260	91	--------	--------	--------	--------	[1] 56,322
1934	8,173	4,871.36	170,254	710	459	3,500	280	2,000	74	171,067

[1] Change in value from previous report of this series due to valuation of gold for 1933 at average weighted price ($25.56 per ounce) instead of at legal coinage value ($20.67+ per ounce).

Mine production of gold, silver, copper, and lead in Wyoming in 1934, by counties, in terms of recovered metals

County	Mines producing		Ore sold or treated	Gold			Silver			Copper	Lead	Total value
	Lode	Placer		Lode	Placer	Total	Lode	Placer	Total			
			Short tons	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Fine ounces*	*Pounds*	*Pounds*	
Albany	2	11	203	44.95	33.25	78.20	6	3	9	2,700	--------	$2,955
Big Horn	----	3	------	--------	12.79	12.79	------	------	------	--------	--------	447
Crook	----	1	------	--------	2.86	2.86	------	------	------	--------	--------	100
Fremont and Carbon [1]	8	22	7,970	1,955.05	2,785.27	4,740.32	342	356	698	800	2,000	166,263
Park	----	2	------	--------	33.39	33.39	------	3	3	--------	--------	1,169
Sublette	----	2	------	--------	3.80	3.80	------	------	------	--------	--------	133
	10	41	8,173	2,000.00	2,871.36	4,871.36	348	362	710	3,500	2,000	171,067

[1] Combined to avoid disclosing metal production of one operator in Carbon County.

REVIEW BY COUNTIES AND DISTRICTS

ALBANY COUNTY

Centennial and La Plata districts.—At the Utopia group of claims 1 mile west of Centennial lessees produced several tons of gold concentrates from test runs of the 35-ton concentrating mill on the property; the concentrates were sold in 1934 to the Golden Cycle mill at Colorado Springs, Colo.

Douglas Creek district (*Holmes, Keystone*).—About 200 cubic yards of gravel were passed through a sluice box during 5 months in 1934 at the Depression No. 1 claim on West Branch of Little Beaver Creek in sec. 14, T. 14 N., R. 79 W., sixth principal meridian; it yielded 6.87 crude ounces of gold nuggets and dust 0.893 fine in gold and 0.100 fine in silver. The operator reported that he was greatly handicapped by lack of water after July. The Medicine Bow Mining Corporation tested ground on Douglas Creek and reported that the company was having machinery designed and built to begin operation in the spring of 1935. Small lots of placer gold were produced from sluicing operations on Douglas, Lake, and Beaver Creeks.

Tie Siding district.—From the Atlas group and concentration mill (built originally in 1928) near Tie Siding, one lot of mixed crude copper ore and concentrates was shipped in 1934 to the Garfield (Utah) smelter.

BIG HORN COUNTY

A prospector sluicing at the Golden Bar placer in Big Horn River Canyon reported production of 2.31 fine ounces of gold during 20 days of operation in 1934. The James Winsor and one other placer north of Kane each produced a small quantity of gold during the year.

CARBON COUNTY

In order to avoid disclosing the metal production from one property, the output of Carbon County in 1934 has been included with that of Fremont County. The only ores mined in Carbon County and sold in 1934 were 6 tons of lead ore from the Meta mine 22 miles southwest of Saratoga and 2 tons of gold ore from the Camp Bird prospect (later abandoned) in the same district. A drag line and an Ainlay 4-bowl unit with a capacity of 500 cubic yards in 10 hours were installed on Saw Mill Creek and operated from August 28 to September 23, producing placer gold 0.905 fine. Small sluicing operations were carried on by individuals on Spring and Savery Creeks.

CROOK COUNTY

The owner of three placer claims on Sand and Spotted Tail Creeks in the Hurricane district near the South Dakota-Wyoming boundary line reported a production of gold valued at $100 from sluicing operations in 1934.

FREMONT COUNTY

Atlantic City district.—The Atlantic City district yielded 96.5 percent of the gold, 93.7 percent of the silver, 25 percent of the lead, and 22.9 percent of the copper produced from Wyoming mines in 1934. Placer mines yielded 58.7 percent of the gold and 53.2 percent of the silver produced in the district compared with 83 and 76 percent, respectively, in 1933. The chief producer of gold in both the district and the State in 1933 and 1934 was the E. T. Fisher Co.,[2] which operated placer ground on Rock Creek. It is equipped with a 1½-cubic yard drag-line bucket; a washing, screening, and amalga-

[2] Ross, Charles L., and Gardner, E. D., Placer-Mining Methods of E. T. Fisher Co., Atlantic City, Wyo.: Inf. Circ. 6846, Bureau of Mines, 1935, 11 pp.

mating plant; and a pumping plant, conveyor belt, and adjustable sluices mounted on rail tracks and pulled ahead with the power of the drag line. The drag line and other equipment are gasoline-powered. At Beaver Gulch, also on Rock Creek, Norman Johnson installed equipment consisting of a 1¼-cubic yard drag line and trommel screen mounted on wheels and moved on tracks. He operated it 2 days in September, recovering 6.29 ounces of gold, but then shut down owing to cold weather. He plans to start again as soon as the season opens in 1935. The Gold Meadow No. 2 placer on Little Beaver Creek was worked by hydraulicking and produced 2 ounces of gold. Other small producers from sluicing operations contributed to the gold output. The Midas Mining Co. operated the McGrath or "1914"-Sullivan property, including the 40-ton amalgamation and flotation mill, for 6 months and produced gold-silver bullion and gold concentrates containing a little silver, copper, and lead. At the Duncan mine development work was done and a new milling plant built and tested, and at the Gold Dollar mine new equipment was added to the mill; shipments of gold bullion from both properties were begun in October and continued through December. Concentrates produced at the Duncan mill were sold to the Midvale (Utah) smelter. Shipments of amalgamation bullion from the Iron Duke property were started in November, and a small lot of gold ore from another property in the district was shipped to the Midvale (Utah) smelter during the year.

Copper Mountain district.—One car of sorted gold ore was shipped from the Gold Nugget property to the Midvale (Utah) smelter in 1934.

PARK COUNTY

A sluicing operation on the Bob, Emma, and Greaser placer claims on Clark Fork south of the Montana-Wyoming boundary line produced most of the gold and all of the silver sold from Park County in 1934. Another operator on Clark Fork, using a drag line and sluice box, produced a small lot of placer gold.

SUBLETTE COUNTY

A small production of gold, made with an experimental machine to save fine gold, was reported by operators from Big Piney who stated that the gold in that locality is too scattered for profitable operation. A dealer in Denver, Colo., purchased a small lot of placer gold from a resident of Big Piney who gave its source as streams near Big Piney.

SECONDARY METALS

By J. P. Dunlop [1]

SUMMARY OUTLINE

The total value of certain nonferrous metals, for which the quantity recovered from secondary sources is reported to the Bureau of Mines, was $127,286,100 in 1934, $26,017,300 more than in 1933; the total quantity increased 18,450 short tons. The increase in total value was due partly to higher average prices for copper, zinc, tin, and antimony; but the recovery of secondary copper, tin, aluminum, antimony, and nickel also increased.

Secondary metals of certain classes recovered in the United States, 1933–34

	1933		1934	
	Short tons	Value	Short tons	Value
Copper, including that in alloys other than brass	247,100	$31,628,800	292,500	$46,800,000
Brass scrap re-treated	130,000	14,378,000	121,300	16,078,000
Lead as metal	131,800	16,613,000	124,500	15,421,600
Lead in alloys	92,700		83,900	
Zinc as metal	48,100	4,678,800	29,300	3,225,000
Zinc in alloys other than brass	7,600		8,200	
Tin as metal	7,250	16,508,700	8,250	25,487,600
Tin in alloys and chemical compounds	14,850		16,650	
Aluminum as metal	14,500	15,343,000	21,000	17,632,000
Aluminum in alloys	19,000		25,400	
Antimony as metal and in alloys	7,400	963,500	7,550	1,346,900
Nickel as metal	300	1,155,000	550	1,295,000
Nickel in nonferrous alloys and salts	1,350		1,300	
	721,950	101,268,800	740,400	127,286,100

Scope of report.—"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, and drosses and are so called to distinguish them from metals derived directly from ores, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality, for metals derived either from ore or from waste material vary in purity and in adaptability to use in making certain products. The figures furnished by producers cover seven metals—secondary copper, lead, zinc, tin, alumi-

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

num, antimony, and nickel—and supplement those on the primary metals. They are given to enable producers and consumers to form a more comprehensive idea of the quantities of metal available for consumption; in fact, they constitute an essential complement to the figures in the general reports on the primary metals and will become more valuable in the future.

The variety of waste material (especially metallic wastes), its utilization, and much information on its collection and disposal appear in reports of this series for preceding years. These reports name the various trade papers that cover the subject of secondary metals and refer to many articles relating to secondary metals recovered.

Garber [2] points out that secondary metals, once humble, are now an important factor in the business of metal refineries. The buying, sampling, and handling of the various scrap metals and residues are described.

Among various other articles relating to the importance of orderly, systematic sorting and control of scrap metals and their influence as a factor in the production and prices of primary metals is one by Von Bernewitz.[3]

During the last year the secondary metal trade has been troubled by many disturbing factors. Scrap-copper exports naturally have diminished, since "Blue Eagle" copper sold for a much higher price than prevailed in foreign markets. Many dealers feel that domestic custom smelters control the secondary copper situation to a large extent and pay less for scrap than is warranted by the selling price of "Blue Eagle" copper. This was a topic discussed by some dealers and by H. O. King,[4] Director of the Copper Code Authority, at a meeting of the Philadelphia Metals Association on November 15, 1934.

The National Association of Waste Material Dealers, Inc., thinks that the Government should enforce the waste-trade codes and relieve the industry of that expense. It also urges no check be imposed on exports of scrap metals of any description and believes that supplies of scrap iron and steel are more than ample for all domestic demand and that the market for the dealers has been benefited by the large exports during the last 18 months. Few waste-trade dealers are interested in the exportation of tin-plate scrap but generally they do not favor restrictions and they universally oppose any ban on scrap-metal alloys containing tin, particularly as such alloys usually contain only a small quantity of tin.

A bill has been introduced in the State Senate of California to prohibit the use of scrap iron or any other scrap in any material used in the construction or repair of any public buildings, bridges, or other structures in California. This legislation has aroused the ire of the scrap-metal dealers and smelters who quite pertinently inquire how the State is to determine what fabricated piece of steel, iron, or other metal contains scrap. No State engineer or any alleged expert could tell. There is nearly certain to be some scrap in all steel alloys, and nonferrous ingots made from scrap properly refined cannot be distinguished from those made from ore.

[2] Garber, P. B., Scrap: Eng. and Min. Jour., September 1934, pp. 408–410.
[3] Von Bernewitz, M. W., Nonferrous Scrap Metals and Melting Practice in the Washington Navy Yard: Metal Ind., May 1935, pp. 163–164.
[4] Waste Trade Journal, Nov. 17, 1934, p. 3; Waste Trade Journal, Apr. 20, 1935, p. 6.

SECONDARY METALS RECOVERED

The quantity of metals contained in numerous alloys made partly or wholly from secondary material cannot be ascertained definitely. The figures in the following tables and text, which are based upon results of the annual canvass, are approximate but constitute the only available data on an industry of growing importance.

Mints and refineries reported the recovery of 23,797,098 fine ounces of silver and 2,032,939 fine ounces of gold from waste or discarded material in 1934. There was an increase of about 1,057,000 ounces in gold.

Jewelry [5] and dental waste furnish the largest quantity of secondary gold, and silverware and photographic waste the largest quantity of secondary silver. The various types of scrap silver produced and the methods of handling them to recover the metallic values have been described by Smith.[6]

No data are collected by the Bureau of Mines showing the quantity of secondary ferrous metals and alloys collected and sold for remelting or the quantity and value of old rails, pipe, machinery, and other equipment renovated for original use. A glance at newspapers and trade publications shows that an enormous quantity of such ferrous material is salvaged and reused.

The price of heavy copper scrap ranged from 5.12 to 6.62 cents a pound in 1934; No. 1 composition scrap from 3.87 to 5.37 cents a pound; old scrap zinc from 1.187 to 2.25 cents a pound; cast aluminum scrap from 6.87 to 9.75 cents a pound; and heavy lead scrap from 2.75 to 3.37 cents a pound. The average weekly quotations for many scrap metals and alloys can be found in the Waste Trade Journal, the Waste Trade Review, and Metal Industry.

The financial mortality among dealers and secondary smelters was quite high in 1934, and few scrap dealers in rural areas did a profitable business. The tendency is still toward elimination of small plants and increased purchase of scrap and drosses by the larger primary smelters of copper and lead. With the increase in the output of primary copper, lead, and zinc (from domestic and foreign sources), the proportion of secondary metals to primary metals receded in 1934, but the proportion for copper and lead still is above normal.

On the whole the waste-trade industry had a poor year. The N. R. A. materially increased operating costs without much higher compensating prices of metals so that most of those in the industry had little if any profit. The fluctuation in prices of most of the metals was much less in 1934, and as there was at no time an actual shortage of scrap there was no opportunity to make much profit. The pegged price of some virgin metals also operated to narrow quoted prices for scrap metals. Some low-grade waste-metal residues, such as ashes and skimmings having a 15- to 20-percent copper content, could not be treated to yield a profit or were held at a price that precluded handling. An editorial in the Waste Trade Journal of April 20, 1935, is headed, "Can the Waste-Material Dealer Survive?"

It appears that the growing practices of direct dealing between makers of waste and the consumers and the various consumers'

[5] Hoke, C. M., Jewelers' Low-Grade Wastes. An Asset or a Liability? Metal Ind., November 1934, pp. 382–384.
[6] Smith, E. A., Treating Waste From Silver Manufacture: Metal Ind., August 1934, pp. 272–273; September 1934, pp. 304–305; October 1934, pp 341–342.

combinations regulating the prices of scrap and waste material have been extremely injurious to waste-material collectors and dealers. Other than those two conditions, which the waste trade hopes to remedy, the market outlook for 1935 is more cheerful. For many in the industry it must be better if they are to continue.

Secondary copper and brass.—The copper produced by smelters of secondary material in 1934 includes 98,445 tons of pig copper (part of which was electrolytically refined), 84,900 tons of copper in remelted brass, and 72,100 tons of copper in alloys other than brass; these figures indicate decreases of 9,136 tons in pig copper, 6,100 tons in copper in brass, and an increase of 18,100 tons in copper alloys other than brass. Regular copper smelters produced about 36,400 tons more secondary copper in 1934 than in 1933 so they were almost entirely responsible for the increase in secondary copper in 1934.

The total value of secondary copper as metal and in brass and other alloys computed at 8 cents a pound (the average price in 1934 of all merchantable grades of new metal) was $60,384,000, about $17,107,200 more than in 1933.

Imports of brass scrap decreased 842 tons and those of copper scrap 67 tons. Brass scrap exported increased 14,848 tons, but copper scrap exported decreased 1,624 tons.

Secondary copper recovered in the United States, 1933–34, and imports and exports of brass and copper scrap, in short tons

	1933	1934
Copper as metal	[1] 193,100	[1] 220,400
Copper in alloys other than brass	54,000	72,100
	247,100	292,500
Copper from new scrap (not including brass)	40,000	35,000
Copper from old scrap (not including brass)	207,100	257,500
	247,100	292,500
Brass scrap remelted:		
New clean scrap	54,000	45,000
Old scrap	76,000	76,300
	130,000	121,300
Copper content of brass scrap (averaging 70 percent copper):		
New scrap	37,800	31,500
Old scrap	53,200	53,400
	91,000	84,900

	1933	1934
Total secondary copper (including copper content of brass scrap):		
From new scrap	77,800	66,500
From old scrap	260,300	310,900
	338,100	377,400
As metal	193,100	220,400
In brass and other alloys	145,000	157,000
	338,100	377,400
Brass scrap imported	1,085	243
Scrap copper imported	130	63
Brass scrap exported	15,348	30,196
Scrap copper exported	14,219	12,595

[1] Of these totals secondary copper reported by smelters and refiners that treat mainly primary metal comprised 85,519 tons in 1933 and 121,955 tons in 1934.

The terms "new brass scrap" and "new copper scrap", as applied in the preceding table, refer to the scrap that is accumulated in fabricating products; "old scrap" is the metal that was made into products and after service has been discarded and returned to be remelted or refined for further use. Few junkmen, dealers, or smelters keep any statistics of "old scrap" and "new scrap." Most of the new scrap is clippings, grindings, and defective articles made in the ordinary operations in fabricating goods, some of which is reused at the plant and the remainder sold. All foundries (many of which purchase scrap metals) are advised in the Bureau of Mines questionnaire to exclude all scrap made and used in their own plants and to give data solely on purchased scrap. Those that purchase only "new scrap" of certain grades and assay can give correct data; the others usually can make no distinction between "new" and "old" scrap. Secondary smelters usually cannot give exact figures but occasionally can estimate the proportion of "new" scrap metal treated. The figures in the preceding table are the best obtainable.

Federal Coordinator of Transportation Eastman late in 1934 sent a questionnaire to all railroads to determine: (1) The costs of handling and preparing scrap for the market and the net revenue from such scrap; (2) the advantage or disadvantage of dismantling equipment versus "sale on wheels" dismantling by outside agencies; (3) the possibilities for economy through the establishment of central scrap plants to serve two or more railroads; and (4) the relative position of the railroads as scrap producers.

Among other data information also is sought on direct dealings between railroads and consumers of scrap. The practice of railroads dealing directly with consumers is very distressing to dealers and brokers. Reports for 1934 show that railroads reused at their shops and foundries the following quantities of scrap metals: 1,400 tons of brass; 530 tons of copper; 9,600 tons of copper in alloys other than brass; 970 tons of tin in babbitt, solder, and bronze; and 3,200 tons of lead in various alloys.

In general there do not appear to be large stocks of copper or brass at fabricating plants or in dealers' yards and pick-ups by collectors of waste material in rural areas and by junk dealers and buyers in small towns and cities remote from secondary smelters apparently are small. Foundries have some stocks of scrap, but such holdings usually are in small lots. The use of various alloys (usually in small quantities) in the manufacture of brass is becoming more prevalent. It is thought that purchasing agents will be required to specify more closely in order to secure the type of metal desired. Secondary copper recovered by smelters of primary copper increased greatly in 1934, and more copper scrap is being refined electrolytically. Anaconda is installing a plant at Perth Amboy to handle brass scrap and automobile radiators. Heretofore Anaconda had confined its scrap purchases to No. 1 and No. 2 heavy copper.

Secondary lead.—The output of secondary lead in 1934 equaled 67 percent of the total production of refined primary lead from domestic and foreign sources in the United States compared with 82 percent in 1933. Much recovered lead is derived from discarded batteries, pipe, sheet, and lead-covered cable; other sources are solder, babbitt, and shot. Little complaint was heard about rebuilt batteries, and they probably were much less of a menace to new batteries than in 1933. The American Bureau of Metal Statistics estimates that 12,900,000 automobile batteries were made in 1934, or 1,700,000 more than in 1933, but about 3,100,000 less than in 1929. The total lead (as oxide or metal) and antimony content of automobile batteries is figured as 163,000 tons compared with 147,000 tons in 1933.

Secondary lead recovered by smelters whose product is mainly primary metal decreased 8,075 tons in 1934. The output of pig lead by secondary smelters increased 775 tons, and lead in scrap alloys decreased 8,800 tons.

Collections of old batteries were about at the same rate in 1934 as in 1933. Collections were good in urban areas but slow in rural areas.

Secondary lead recovered in the United States, 1933–34, in short tons

	1933	1934
Secondary lead recovered by smelters that treat mainly ore	41,632	33,557
Secondary lead recovered by smelters that treat only scrap and drosses	90,168	90,943
	131,800	124,500
Secondary lead recovered in remelted alloys:		
Estimated secondary lead content of antimonial lead produced at regular lead smelters [1]	11,136	8,113
Lead content of drosses and scrap alloys treated at secondary smelters	81,564	75,787
	92,700	83,900
Total secondary lead recovered	224,500	208,400

[1] Antimonial lead produced at primary smelters totaled 17,805 tons containing approximately 4,158 tons of primary domestic lead, 791 tons of primary foreign lead, 870 tons of primary domestic antimony, 57 tons of primary foreign antimony, 11,136 tons of secondary lead and 793 tons of secondary antimony in 1933 compared with 16,607 tons containing approximately 5,901 tons of primary domestic lead, 330 tons of primary foreign lead, 1,657 tons of primary domestic antimony, 18 tons of primary foreign antimony, 8,113 tons of secondary lead, and 588 tons of secondary antimony in 1934.

Refined primary lead produced in the United States, 1933–34, in short tons

	1933	1934
From domestic ore	259,616	299,841
From foreign ore and base bullion	13,963	11,395

A number of secondary smelters treating old batteries and other lead alloys now recover most of the lead as good-grade pig lead. The residues and drosses containing antimony are then used in making hard lead containing various percentages of antimony.

Some of the difficulties in sampling old batteries are stated in an article by Johnstone.[7] The sampling of battery plates is much more difficult than the assaying due to the moisture in the rubber and separators.

Part of the old batteries are smelted on toll by custom smelters. The smelters also purchase batteries at a price based on that of pig lead at St. Louis, the antimony content being paid for at the price of lead though the price of antimony in 1934 was more than double that of lead.

Secondary zinc.—Secondary zinc recovered as pig metal and in alloys (including brass) decreased 21,700 short tons, largely in redistilled and remelted zinc from drosses. The quantity of remelted brass also decreased, though the zinc in alloys other than brass increased slightly. The zinc content of brass remelted was 3,500 tons less in 1934 than in 1933. The total recovery of secondary zinc (including that in brass) equaled 18 percent of the total output of primary slab zinc in the United States (363,590 tons) in 1934. In addition, large quantities of zinc dust, zinc chloride, and other compounds were made from zinc drosses and residues.

[7] Johnstone, J. O., Sampling Battery Plates: Waste Trade Jour., May 4, 1935, p. 4.

Secondary zinc[1] *recovered in the United States, 1933–34, and products made from zinc dross, skimmings, and ashes, in short tons*

	1933	1934
Secondary zinc recovered by redistillation	30,087	19,691
Secondary zinc recovered by sweating, remelting, etc	18,013	9,609
Total zinc recovered unalloyed	48,100	29,300
Zinc recovered in alloys other than brass	7,600	8,200
Zinc recovered in brass (estimated)	32,500	29,000
Zinc dust made from zinc dross	11,157	10,856
Zinc dross used for zinc dust (estimated)	13,000	12,850
Zinc concentrates and ore exported Zinc dross exported	809	3,452
Lithopone made from zinc skimmings and ashes	56,521	54,489
Secondary zinc content of lithopone	11,288	10,836
Zinc chloride made from zinc skimmings, ashes, etc	30,370	19,166
Zinc content of zinc chloride made from zinc skimmings, etc	6,680	4,216
Zinc content of zinc sulphate made from zinc skimmings, ashes, etc	864	411

[1] Figures do not include scrap and dross used for lithopone, oxide, zinc dust, or chloride. The use for some of these, especially for zinc chloride, is large.

Zinc recovered by redistillation decreased from 30,087 tons in 1933 to 19,691 tons in 1934. Of the 1934 total 4,962 tons (a decrease of 9,268 tons) were recovered at primary smelters from zinc drosses and 14,729 tons (a decrease of 1,128 tons) at 5 secondary plants using large graphite retorts and 2 plants using clay retorts which treated only drosses and residues in 1934. The 5 active zinc smelters using large graphite retorts in 1934 were:

Federated Metals Corporation, Trenton, N. J.
General Smelting Co., Philadelphia, Pa.
Nassau Smelting & Refining Co., Tottenville, N. Y.
Superior Zinc Corporation, Bristol, Pa.
Wheeling Steel Corporation, Wheeling, W. Va.

Of the total output of 146,968 tons of lithopone in 1934, 54,489 tons containing 10,836 tons of zinc were made from zinc skimmings and ashes.

The quantity of zinc chloride made in 1934 was 19,254 tons (50° B.) of which 19,166 tons containing 4,216 tons of zinc were from zinc residues.

The American Bureau of Metal Statistics estimates that 152,000 tons of zinc (4,000 tons more than in 1933) were used in 1934 in zincking (galvanizing) sheets, forms, tubes, wire, and other materials.

Secondary tin.—Secondary tin recovered amounted to 24,900 short tons valued at $25,487,600 in 1934 compared with 22,100 tons valued at $16,508,700 in 1933. The total value assigned is based on the yearly average price (51.18 cents a pound in 1934 and 37.35 cents in 1933) given by the American Metal Market for 99 percent metal, prompt delivery at New York. The total recovered increased 2,800 tons, 1,800 tons being in tin in alloys. Recovery of tin from scruff and drosses increased from about 4,600 tons in 1933 to 5,200 tons in 1934.

Secondary tin recovered in 1934 was equivalent to about 55.6 percent of the tin imported into the United States as pig metal in 1934.

According to the American Iron and Steel Institute the quantity of tin plate and terneplate made was 1,603,229 long tons in 1934 compared with 1,769,098 tons in 1933. It is estimated that 26,200 long tons of tin were used in these products.

Many earlier chapters of this series contain data on plants and processes followed, and a complete history of the different methods of detinning is given in an article entitled "Scrap Detinning Affords Big Outlet for Chlorine", by C. L. Mantell in Chemical and Metallurgical Engineering, August 1926 (pp. 477–479).

In order to determine the extent to which the United States is dependent upon foreign countries for its supply of tin, and for other purposes, a subcommittee of the House Committee on Foreign Affairs made an investigation of the tin situation resulting in a report of 1,111 pages, transmitted by Chairman McReynolds on April 15, 1935.

Accompanying the report, Chairman McReynolds submitted a bill authorizing the President, on recommendation of a proposed board for strategic materials, to regulate the exportation of tin scrap and to assist in building up a domestic smelting industry by imposing an excise tax of 6 cents a pound on all metallic tin not produced in the United States.

The principal remedies suggested by the committee to lessen the dependence of the United States on foreign countries, in brief, follow:

1. Increased importation of tin ore and establishment of a smelting industry in the United States.
2. More thorough prospecting of possible sources of tin ore in the United States.
3. Well-organized and Government-financed research for tin substitutes.
4. Prohibition of the exportation of tin-bearing scrap, and possibly all tin-bearing material.
5. Acquisition and holding by the Government of a reserve stock of tin for use in an emergency.

The committee recommends legislation which will provide the following:

1. Establishment and declaration of a general policy with regard to certain materials essential to industry and the national defense, in which our natural resources are either deficient or not sufficiently developed.
2. Creation of a special agency of the Government with powers and duties appropriate to the carrying out of the policy declared.
3. Relief of the tin situation by certain specific applications of the declared policy.

The conclusions and proposed remedies of the committee as reported above do not concern the waste trades other than those relating to the prohibition or restriction of exports of tin-bearing material. All oppose any restriction on export of scrap metals. Few are interested in the export of tin-plate scrap, but much of the brass and bronze scrap exported contains some tin and restrictions against export of all tin-bearing material might thus restrict exports of various alloys. Moreover this restriction might be extended to alloys containing nickel and other metals which are not produced largely from domestic sources.

The detinning industry, while not demanding complete prohibition of exports of tin-plate scrap, does desire to restrain unlimited exports of material upon which the industry mainly depends. Plant capacity is geared to take care at all times of all United States tin-plate scrap accumulations. Operating costs vary sharply with tons of scrap detinned. The shipment abroad of raw material starts a downward cycle which brings higher operating costs and lowers prices that can be paid for scrap. Increased quantities of scrap available permit higher prices to be paid for such scrap.

There are no data available on the export of tin-plate clippings in 1934. It has been estimated that 6 percent of the scrap iron and steel shipments to Japan in 1934 were tin-plate scrap. The estimate appears high. Another estimate for such exports is 30,000 long tons. In March 1935 the exports were 2,646 tons of tin-plate clippings and 1,153 tons of waste tin plate. The average monthly quantity of tin-plate scrap detinned in the United States in 1934 was about 13,500 long tons. The detinners state that there is good reason to assume that large quantities of scrap tin plate have been and are being exported as "scrap steel" from points having rail rates for export on scrap iron and steel materially lower than corresponding export rates on tin-plate scrap. It is stated that some manufacturers of tin-plate products have obtained yearly contracts directly with exporters. The exportation of iron and steel scrap is a very live subject in waste-trade circles.[8]

The advance in the price of tin to more than 50 cents a pound in 1934 resulted in the detinning of old tin-coated containers (about 2,400 tons) for the first time in many years. The old cans yield much less tin than clean tin-plate clippings. Many more old cans may be treated at the plants now equipped to handle them, but the high cost of collection and shipping militates against their use. There are also the additional costs of cleaning and handling a bulky material. Thus the use of old tin-coated containers probably will be confined to areas adjacent to the detinning plants.

Secondary tin recovered in the United States, 1933–34

	1933	1934
Tin recovered as pig tin……short tons..	7,250	8,250
Tin recovered in alloys and chemical compounds……do….	14,850	16,650
	22,100	24,900
Clean tin-plate scrap treated at detinning plants……long tons..	155,844	162,262
Metallic tin recovered at detinning plants……pounds..	1,876,642	2,106,920
Tin content of tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants……pounds..	4,015,259	3,944,171
Total tin recovered at detinning plants……do….	5,891,901	6,051,091
Tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants……pounds..	8,640,013	8,377,421
Average quantity of tin recovered per long ton of clean tin-plate scrap……do….	37.8	37.3

Tin (metal) and tin concentrates (tin content) imported into the United States, 1933–34, in short tons

	1933	1934
Tin imported as metal	71,364	44,784
Tin concentrates (tin content) imported	27	2

8 Cohen, Paul, Should U. S. Scrap-Iron Exports Be Banned? Waste Trade Jour., May 11, 1935, p. 6.

The quantity of tin-plate clippings treated at detinning plants increased about 6,400 long tons in 1934, and the average cost of such clippings delivered at plants increased from $6.83 a long ton in 1933 to $13.64 a ton in 1934. These clippings were treated at plants of the Vulcan Detinning Co. at Sewaren, N. J., Neville Island, Pa., and Streator, Ill.; by the Johnston & Jennings Co. of Cleveland, Ohio; and at the plants of the Metal & Thermit Co., at South San Francisco, Calif., East Chicago, Ind., and Chrome, N. J.

Tin-plate clippings imported in 1934 are not available and probably were less than in 1933, for it is reported that some tin-plate clippings normally shipped to the United States from Canada were diverted to Japan in 1934.

Exports of iron and steel scrap (including clean tin-plate clippings) in 1934 were 1,835,564 long tons, of which 1,168,496 tons including all the tin-plate clippings, went to Japan.

The tin reported recovered in alloys and compounds in 1934 included the tin content of products made from clean tin-plate scrap. Most of the tin recovered at the plants listed was in tin bichloride, tin crystals, tin tetrachloride, and tin oxide.

The total recovery of tin as metal or in compounds from clean tin-plate scrap in 1934 was 3,026 short tons, whereas it is estimated that makers of tin plate and terneplate consumed more than 29,300 short tons of tin.

A plant in Los Angeles collected old cans locally for use in shredded scrap to precipitate copper from mine waters, but there was no attempt to recover the tin coating.

A book by C. L. Mantell, of Pratt Institute, Brooklyn, N. Y., Tin: Its Mining, Production, Technology, and Application, includes chapters on the sources of secondary tin and the various methods of detinning tin-plate scrap.

Secondary aluminum.—The recovery of secondary aluminum, including that in alloys, totaled 46,400 short tons valued at $17,632,000 compared with 33,500 tons valued at $15,343,000 in 1933. The value in 1934 was computed at 19 cents a pound and in 1933 at 22.9 cents a pound.

The value of primary aluminum produced in the United States declined from $16,174,000 in 1933 to $14,094,000 in 1934 owing to a decrease of about 13 percent in output and a decrease of 17 percent in the average price for aluminum.

Secondary aluminum recovered in the United States, 1933–34, in short tons

	1933	1934
Secondary aluminum recovered unalloyed	14,500	21,000
Aluminum recovered in alloys (mainly No. 12)	19,000	25,400
	33,500	46,400

Primary aluminum produced in the United States and imported and exported, 1933–34, in pounds

	1933	1934
Primary aluminum produced in the United States	85,126,000	74,177,000
Aluminum (crude and semicrude) imported for consumption	15,246,696	18,591,591
Aluminum (crude and semicrude) exported	5,707,661	8,365,557

The spread in scrap-aluminum castings was nearly 3 cents a pound in 1934, the demand was usually good, and the quantity available was cleaned up fairly well. Aluminum cylinder heads and aluminum-alloy pistons were used more extensively in motor cars than formerly, so that an increased quantity of scrap aluminum was consumed in the automobile industry. Scrap cast aluminum and old crankcases were in good demand. It is said that many of the new 1935 cars require as much as 45 pounds of aluminum.

A large number of alloys containing aluminum contribute to the secondary aluminum recovered, but No. 12 (a mixture of about 92 percent aluminum and 8 percent copper) constitutes the largest supply of material for remelting and refining. Other alloys are numerous but are used in smaller quantities. Many automobile aluminum crankcases are sold to foundries and do not reach the secondary smelters.

The approved standard methods of sampling and analyzing aluminum and its alloys are described in a pamphlet published by the Aluminum Research Institute in July 1932. A book[9] by Anderson is interesting to smelters and users of secondary aluminum.

The market for mixed cast-aluminum alloys was generally weak early in 1934 but rather active in the fall. Prices for scrap cast aluminum ranged from 6.87 cents a pound in January to as high as 9.75 cents in December.

Secondary antimony.—The principal materials refined or remelted that contained antimony as an alloy were hard-lead drosses, babbitt, bearing metal, battery plates, pewter, and type metal. The antimony used in the pigment, paint, and ceramic industries is so dissipated that no secondary recoveries can be made, but a large proportion of the production of metal containing antimony returns in a few months or a few years for refining and reuse. Antimony in type metal and in bearings returns very rapidly for refining. This large return of scrap in type and bearing metals normally goes to the makers of type and bearing alloys, which restricts the market for antimonial lead. Antimony in battery plates may take several years to return as scrap, but probably 85 percent is certain to come back for reuse.

The production of secondary antimony in the United States, most of which was recovered in alloys, increased very little in 1934. The average price for ordinary brands of antimony, as stated by the American Metal Market, was 8.92 cents a pound in 1934 compared with 6.51 cents in 1933. The price advanced rapidly late in 1934 and was quoted at about 13.8 cents a pound in December. Smelters that ordinarily use primary ores, concentrates, or metal reported 1,675 tons of primary antimony and 588 tons of secondary antimony as contained in 16,607 tons of antimonial lead. The recovery of secondary antimony by secondary smelters increased 355 tons.

Imports of antimony in ore, as metal, or in oxide were 99 tons less than in 1933.

[9] Anderson, R. J., Secondary Aluminum: The Sherwood Press, Inc., Cleveland, Ohio, 1931, 563 pp.

Secondary antimony recovered in and antimony imported into and exported from the United States, 1933–34, in short tons

	1933	1934
Secondary antimony in antimonial lead scrap smelted at regular smelters	793	588
Secondary antimony recovered at secondary smelters	6,607	6,962
	7,400	7,550
Antimony imported in ore, as metal, or as oxide or salts	5,473	5,374
Foreign antimony exported	98	402

Secondary nickel.—The nickel reported as recovered from secondary sources includes nickel in Monel metal (the natural alloy) but not that in ferrous alloys. The practice of using small quantities of nickel in iron and steel, also in brasses and bronzes, expanded again in 1934.

The secondary nickel reported as recovered in 1934 came mainly from scrap-nickel anodes, nickel silver, copper-nickel alloys, and Monel metal. Nickel is also used in white gold and in aluminum and zinc alloys for die castings.

There were large exports of nickel scrap and of scrap alloys containing nickel, though probably no greater quantity than in 1933. Scrap dealers are not especially desirous of giving their exports, but the few who did report to the Bureau of Mines stated a total of 160 tons. Incidentally (although not specifically requested) some users of nickel reported the purchase of steel scrap containing about 1,200 tons of nickel.

The secondary recovery of nickel in ferrous alloys probably was below normal owing to slow recovery of the durable-goods industry. It is estimated by Robert C. Stanley, president of the International Nickel Co., Ltd., that about 42 percent of the nickel consumed in the United States is used in nickel steel and iron, mainly in motor cars, railway equipment, heat-resistant alloys, and general machinery. The remainder is used as Monel metal, rolled nickel, sheets, rods, and shot, in nickel silver, for nickel plating, and in alloys of copper and other nonferrous metals. Probably more secondary nickel is recovered from ferrous alloys than from nonferrous alloys, but no total figures are available. The recoveries given from nonferrous alloys probably are greater than inquiries reveal, for it is difficult to ascertain the quantity of nickel in alloys remelted when the quantity of nickel in the alloy is frequently very small. It is estimated that the quantity of nickel now used yearly in special alloys of brass and bronze exceeds 500 tons.

Secondary nickel recovered in the United States, 1933–34, in short tons

	1933	1934
Nickel recovered as metal	300	550
Nickel recovered in nonferrous alloys and salts	1,350	1,300
	1,650	1,850

Primary nickel produced in the United States and imported and exported, 1933–34, in short tons

	1933	1934
Nickel produced as a byproduct from the electrolytic refining of copper at domestic refineries	126	157
Nickel imported for consumption in the United States as nickel or in nickel ores and matte, oxide, and alloys	26,430	29,298
Nickel, Monel metal, and other alloys exported	755	2,308

Analyses of various nickel alloys were published in Mineral Resources for 1915.[10] Considerable information as to the uses of nickel, Monel metal, and other nickel alloys is given in Inco and in special pamphlets on nickel and its various alloys, publications of the International Nickel Co. This company purchases nickel scrap and Monel scrap.

CLASSIFICATION OF OLD METALS

The classification of old metals drawn up by the Metals Division of the National Association of Waste Material Dealers, Inc., Times Building, New York, N. Y., and changed from time to time as desirable, is the standard of both dealers and manufacturers in the United States. The latest classification (Circular M), effective March 16, 1932, follows.

Standard Classification for Old Metals, Effective from March 16, 1932

1. *Delivery.*—(*a*) Delivery of more or less of the specified quantity up to 1¼ percent is permissible.

(*b*) If the term "about" is used, it is understood that 5 percent more or less of the quantity may be delivered.

(*c*) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages an arbitration committee of the National Association of Waste Material Dealers, Inc., appointed for this purpose, to determine the amount of such damages.

(*d*) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to an arbitration committee of the National Association of Waste Material Dealers, Inc., to be appointed for that purpose.

(*e*) A carload, unless otherwise designated, shall consist of the weight governing the minimum carload weight at the lowest carload rate of freight in the territory in which the seller is located. If destination of material requires a greater carload minimum weight, buyer must so specify.

(*f*) A ton shall be understood to be 2,000 pounds unless otherwise specified. On material purchased for direct foreign shipment a ton shall be understood to be a gross ton of 2,240 pounds unless otherwise specified.

(*g*) If, through embargo, a delivery cannot be made at the time specified, the contract shall remain valid and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed.

(*g*–1) When shipments for export for which space has been engaged have been delivered or tendered to a steamship for forwarding and through inadequacy of cargo space the steamship cannot accept the shipment, or where steamer is delayed in sailing beyond its scheduled time, shipment on the next steamer from the port of shipment shall be deemed a compliance with the contract as to time of shipment.

(*h*) In case of a difference in weight and the seller is not willing to accept buyer's weights, a sworn public weigher shall be employed, and the party most in error must pay the costs of handling and reweighing.

[10] Hess, Frank L., Nickel: U. S. Geol. Survey, Mineral Resources of the U. S., 1915, pt. I, pp. 763–765.

(*i*) When material is such that it may be sorted by hand, consignees cannot reject the entire shipment if the percentage of rejection does not exceed 10 percent. The disposition of the rejected material should then be arranged by negotiations; no replacement of the rejected material to be made.

Upon request of the shipper, rejections shall be returnable to the seller on domestic shipments within 1 week and on foreign shipments within 30 days from the time notice of rejection is received by them, and upon payment by them of 1 cent a pound on material rejected to cover cost of sorting and packing; the seller to be responsible for freight both ways.

2. *No. 1 copper wire.*—To consist of clean untinned copper wire not smaller than No. 16 B. & S. Wire gage to be free from burnt copper wire which is brittle and all foreign substances.

3. *No. 2 copper wire.*—To consist of miscellaneous clean copper wire which may contain a percentage of tinned wire and soldered ends but to be free of hair wire and burnt wire which is brittle; the tinned wire not to be over 15 percent of the total weight.

4. *No. 1 heavy copper.*—This shall consist of untinned copper not less than 1/16 inch thick, and may include trolley wire, heavy field wire, heavy armature wire, that is not tangled, and also new untinned and cleaned copper clippings and punchings, and copper segments that are clean.

5. *Mixed heavy copper.*—May consist of tinned and untinned copper, consisting of copper clippings, clean copper pipe and tubing, copper wire free of hair wire and burnt and brittle wire, free from nickel-plated material.

6. *Light copper.*—May consist of the bottoms of kettles and boilers, bathtub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free from radiators, brass, lead and solder connections, readily removable iron, old electrotype shells, and free of excessive paint, tar, and scale.

7. *Composition or red brass.*—May consist of red scrap brass, valves, machinery bearings and other parts of machinery, including miscellaneous castings made of copper, tin, zinc and/or lead, no piece to measure more than 12 inches over any one part or to weigh over 60 pounds, to be free of railroad boxes and other similarly excessively leaded material, cocks and faucets, gates, pot pieces, ingots, and burned brass, aluminum composition, manganese, and iron.

8. *Railroad bearing.*—Shall consist of railroad boxes or car journal bearings, must be old standard used scrap, free of yellow boxes, also iron-backed boxes, and must be free of babbitt, also free of excessive grease and dirt.

9. *Cocks and faucets.*—To be mixed red and yellow brass, free of gas cocks and beer faucets, and to contain a minimum of 35 percent red.

10. *Heavy yellow brass.*—May consist of heavy brass castings, rolled brass, rod brass ends, chandelier brass, tubing, not to contain over 15 percent of tinned and/or nickel-plated material; no piece to measure more than 12 inches over any one part and must be in pieces not too large for crucibles. Must be free of manganese mixture, condenser tubes, iron, dirt, and excessive corroded tubing. Must be free of aluminum brass containing over 0.20 percent aluminum.

11. *Yellow brass castings.*—Shall consist of brass castings in crucible shape, that is, no piece to measure more than 12 inches over any one part; must be free of manganese mixtures, tinned and nickel-plated material, and must be free of visible aluminum brass.

12. *Light brass.*—May consist of miscellaneous brass, tinned or nickel plated that is too light for heavy brass, to be free of gun shells containing paper, ashes or iron, loaded lamp bases, clock works, and automobile gaskets. Free of visible iron unless otherwise specified.

13. *Old rolled brass.*—May consist exclusively of old pieces of sheet brass and pipe free from solder, tinned and nickel-plated material, iron, paint, and corrosion, ship sheathing, rod brass, condenser tubes, and Muntz metal material.

14. *New brass clippings.*—Shall consist of the cuttings of new sheet brass to be absolutely clean and free from any foreign substances and not to contain more than 10 percent of clean brass punchings to be not smaller than 1/4 inch in diameter.

15. *Brass pipe.*—Shall consist of brass pipe, free of nickel-plated, tinned, soldered, or pipes with cast brass connections. To be sound, clean pipes free of sediment and condenser tubes.

16. *No. 1 red composition turnings.*—To be free of railroad car box turnings and similarly excessively leaded material, aluminum, manganese, and yellow brass turnings; not to contain over 2 percent free iron; to be free of grindings and foreign material, especially babbitt. Turnings not according to this specification to be sold subject to sample.

17. *No. 1 yellow rod brass turnings.*—Shall consist of strictly rod turnings, free of aluminum, manganese, composition, Tobin and Muntz metal turnings; not to

contain over 3 percent free iron, oil, or other moisture; to be free of grindings and babbitts; to contain not more than 0.30 percent tin and not more than 0.15 percent combined iron.

18. *No. 1 yellow brass turnings.*—Shall consist of yellow brass turnings, free of aluminum, manganese, and composition turnings; not to contain over 3 percent of free iron, oil, or other moisture; to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.

19. *Auto radiators (unsweated).*—All radiators to be subject to deduction of actual iron. The tonnage specifications should cover the gross weight of the radiators, unless otherwise specified.

20. *No. 1 pewter.*—Shall consist of tableware and soda-fountain boxes, but in any case must test 84 percent tin. Siphon tops to be treated for separately.

21. *Zinc.*—Must consist of clean sheet and cast zinc, also cast batteries to be free of loose oxide and dross, sal ammoniac cans, and other foreign materials.

22. *Zinc dross.*—Must be unsweated in slabs and must contain a minimum of 92 percent of zinc.

23. *Tin foil.*—Shall consist of pure foil free of lead compositions and other foreign ingredients and matters.

24. *Electrotype shells.*—Must be hand picked and free of loose dross and chunks of dross.

25. *Scrap lead.*—Should be clean, soft scrap lead.

26. *Battery lead plates.*—Shall consist of dry battery lead plates, moisture not to exceed 1 percent, allowance to be made for wood, rubber, and paper and excess moisture, or lead plus antimony content, dry basis, less a treatment charge.

27. *New pure aluminum clippings.*—Shall consist of new, clean, unalloyed sheet clippings and/or aluminum sheet cuttings. Must be free from oil, grease, and any other foreign substance. Also to be free from punchings less than one-half inch square.

28. *New pure aluminum wire and cable.*—Shall consist of new, clean, dry, unalloyed aluminum wire or cable, free from iron, insulation, and any other foreign substance.

29. *Old pure aluminum wire and cable.*—Shall consist of old, unalloyed aluminum wire or cable containing not over 1 percent free oxide or dirt and free from iron, insulation, and any other foreign substance.

30. *Alloy sheet aluminum.*—To be sold on specification and sample.

31. *Painted sheet aluminum.*—Shall consist of clean, old, painted, unalloyed sheet aluminum, guaranteed free from iron, dirt, and any other foreign substance. To contain no radiator shells or aeroplane sheet.

32. *Old scrap sheet aluminum.*—Shall consist of clean, old, unalloyed sheet or manufactured sheet aluminum, guaranteed free from iron, dirt, or any other foreign substance, and to be free from hub caps, radiator shells, and airplane sheet.

33. *Scrap aluminum castings.*—Shall consist of clean, heavy automobile castings, containing not more than 12 percent industrial mixed castings, and to be free from die cast aluminum, pattern metal, and hat blocks. All of above material also to be free from iron, babbitt, brass, and any other foreign substance. Oil and grease must not exceed 2 percent.

34. *Aluminum borings.*—To avoid dispute, should be sold subject to sample.

35. *Aluminum foil.*—Shall consist of pure aluminum foil, free from paper and any foreign ingredients.

36. *Babbitt metal.*—Shall contain bearing metal of all kinds. Shall not contain scrap hard metal, Allen metal (which is copper and lead alloy) die cast, ornamental metal, casket metal, zinc boxes, or type metal.

37. *Packages.*—Shall be good strong packages suitable for shipment and each package shall be plainly marked with separate shipping marks and numbers and with the gross and tare weights so that the packages may reach their destination and their weights can be easily checked.

There is a growing demand for scrap-metal specialties (not specifically covered by the preceding classification), such as nickel alloys, German silver, Monel metal, cadmium, and molybdenum. Difficulties in making shipments to buyers' specifications have arisen, and with the object of eliminating some of the trouble the Waste Trade Journal published certain classifications used by one of its advertisers. A list of these was given on pages 338 and 339 of the Secondary Metals chapter in Mineral Resources of the United States, 1930, part I.

IRON ORE, PIG IRON, FERRO-ALLOYS, AND STEEL

By O. E. Kiessling and H. W. Davis [1]

SUMMARY OUTLINE

Although the American iron and steel industry showed further recovery in 1934, a comparison of operations with 1922–29 and even with the initial depression year 1930 indicates that activity was still relatively low. The production of steel and of pig iron required only 37 and 31 percent, respectively, of the potential productive capacities of steel mills and blast furnaces compared with 33 and 26 percent, respectively, in 1933. The higher rate of operation in 1934 and relatively better prices for iron and steel products improved the financial position of the steel industry. Larger pig iron and steel outputs also reacted to the benefit of producers of other mineral products, such as iron ore, manganiferous iron ore, fluorspar, fluxing stone, and coke, who depend upon the iron and steel furnaces as their principal market. The trends in production of iron ore, pig iron, and steel for more than half a century are illustrated in figure 16.

The relative consumption of iron and steel products shifted noticeably in 1934 due to the substantial improvement in demand by capital-goods industries. Buoyed by purchases made possible by Government funds, the railroads advanced from fourth place in 1933 to second place in 1934 as a consumer of steel. Federal projects also contributed to increased consumption in the building industry, and

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

there was more demand for iron and steel for shipbuilding requirements. The demand for pipe was stimulated greatly during 1934 but was relatively small compared with the requirements during years when long-distance pipe lines for transmission of gas and oil were under construction.

The demand for iron and steel by consumer-goods industries, except by metal fabricators, also improved during 1934. The automobile industry, for example, produced 2,753,111 cars in 1934, compared with 1,920,057 cars in 1933, and took about one-fifth of the total steel output. The increased income of the farmer and his

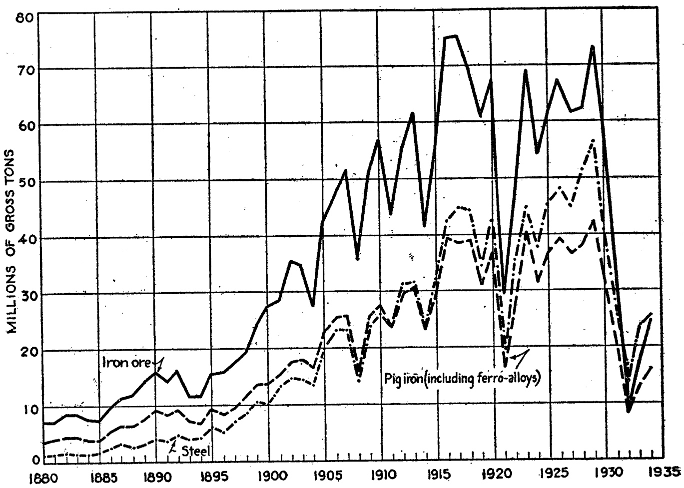

FIGURE 16.—Trends in production of iron ore, pig iron, and steel in the United States, 1880–1934.

ability to purchase new farm equipment resulted in farm-implement manufacturers taking about 7½ percent of the total output, compared with 4 percent in 1933. Demand for tin plate in 1934, on the other hand, failed to measure up to the requirements of 1933, and metal-container fabricators—the second largest customer in 1933—dropped to fourth place in 1934.

The general trend in prices of finished steel was higher than in 1933. Quotations on bars, plates, shapes, wire rods, and automobile sheets were about $2 to $10 a gross ton more than in 1933 and tin plate was 82 cents a base box higher. The price of rails was an exception to the tendency for increases and dropped $3 a ton below 1933.

Salient statistics of iron ore, pig iron, ferro-alloys, and steel in the United States, 1933–34

	1933		1934	
	Gross tons	Value	Gross tons	Value
Iron ore:				
Production:				
Hematite	16, 920, 672		[2] 23, 390, 993	
Brown ore	235, 297	(1)	286, 073	(1)
Magnetite	396, 720		[2] 909, 910	
Carbonate	499		640	
	17, 553, 188	(1)	24, 587, 616	(1)
Open pit	[3] 11, 335, 809	(1)	[4] 14, 054, 417	(1)
Underground	[3] 6, 217, 379		[4] 10, 533, 199	
	17, 553, 188	(1)	24, 587, 616	(1)
Shipments (exclusive of ore for paint)	24, 624, 285	$63, 776, 033	25, 792, 606	$66, 483, 846
Average value per ton at mines		2. 59		2. 58
Stocks at mines	10, 953, 021	(1)	10, 340, 690	(1)
Imported	861, 153	2, 054, 312	1, 427, 521	3, 307, 504
Exported	155, 271	646, 533	608, 922	2, 243, 066
Pig iron:				
Production	13, 027, 343	(1)	15, 686, 442	(1)
Shipments	14, 353, 197	213, 347, 583	15, 632, 619	264, 653, 746
Average value per ton at furnaces		14. 86		16. 93
Imported for consumption	134, 456	1, 244, 937	114, 488	1, 465, 475
Exported	2, 750	63, 985	4, 096	97, 050
Ferro-alloys:				
Production	348, 894	(1)	452, 607	(1)
Shipments:				
Ferromanganese	127, 453	9, 384, 611	147, 947	12, 345, 697
Spiegeleisen	50, 218	1, 144, 642	45, 769	1, 099, 922
Ferrosilicon	199, 524	7, 349, 681	181, 209	7, 401, 799
Other varieties	44, 228	10, 774, 860	53, 873	13, 787, 539
	421, 423	28, 653, 794	428, 798	34, 634, 957
Imported for consumption:				
Ferromanganese	39, 693	2, 548, 068	23, 349	1, 441, 360
Spiegeleisen	26, 277	640, 613	21, 184	595, 017
Ferrosilicon	5, 290	145, 892	6, 537	189, 954
Steel production:				
Open hearth:				
Basic	20, 057, 146		23, 256, 417	
Acid	324, 526		274, 688	
Bessemer	2, 428, 791	(1)	2, 162, 357	(1)
Crucible	681		531	
Electric	421, 203		361, 296	
	23, 232, 347	(1)	26, 055, 289	(1)

[1] Figures not available.
[2] Some hematite included with magnetite.
[3] Revised figures.
[4] Some open pit included with underground.

The prices of pig iron, ferromanganese, spiegeleisen, iron and steel scrap, and fluorspar reflected the upward trend in steel quotations. Compared with 1933 the average price of pig iron advanced $2.07 a gross ton (from $14.86); ferromanganese increased $9.82 a ton (from $73.63); spiegeleisen, $1.24 a ton (from $22.79); heavy melting steel scrap at Pittsburgh, $1.15 a ton (from $11.21); and fluorspar, $2.02 a ton (from $11.40). Price advances also were recorded for some raw materials used in blast-furnace burdens, such as scrap, fluxing stone, and coke. Figure 17 shows trends in prices of iron ore, pig iron, finished steel, and steel scrap.

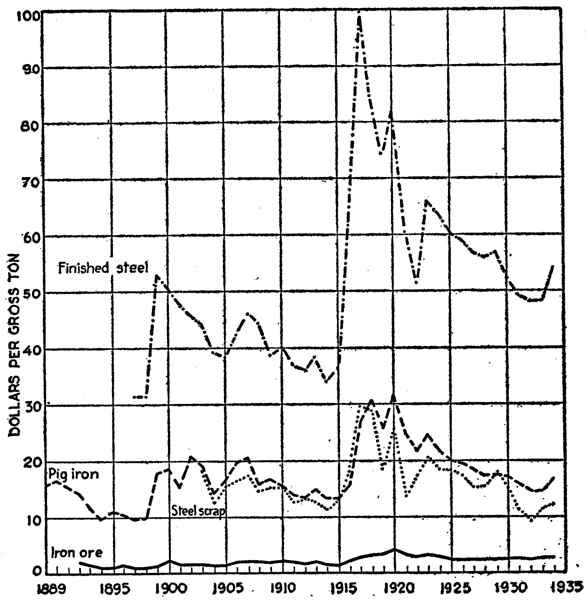

FIGURE 17.—Trends in prices of iron ore, pig iron, finished steel, and steel scrap. The prices of iron ore and pig iron are the averages f. o. b. mines and furnaces, respectively, as reported to the U. S. Bureau of Mines; the price of finished steel is an average composite computed by American Metal Market; that of steel scrap is an average at Pittsburgh of No. 1 heavy melting computed by Iron Age.

The export trade in iron and steel products gained substantially in 1934, and most products shared in the improved business. The exports of tin plate and terneplate were an important item among semifinished steel products, amounting to 184,651 gross tons in 1934 compared with 95,239 tons in 1933. Among other semifinished and finished products exported in comparatively large volume the increased overseas movement of steel ingots, etc., steel bars, unfabricated plates, black steel sheets, structural shapes, rails, and tubular products was noteworthy. By far the most conspicuous among iron and steel products exported in 1934 was scrap, which totaled 1,835,564 gross tons, of which 1,168,496 tons went to Japan, compared with total exports of 773,406 tons in 1933, of which 547,539 tons went to Japan.

On the other hand, most of the articles which account for the bulk of the iron and steel products imported for consumption showed further decreases in 1934. Among these items were steel bars, structural iron and steel, rails, tubular products, wire rods, and scrap.

Code developments under N. R. A.—A code of fair competition for the iron and steel industry, which was approved by President Roosevelt for a 90-day trial period on August 19, 1933, and later extended to May 31, 1934, was extended indefinitely by the President on May 30, 1934. Among the few price revisions made in the code were the establishment of additional basing points, a provision for filing prices regardless of cost, and permission to meet price reduction of a competitor as soon as it becomes effective. The 8-hour day was established unconditionally for the entire industry. The average 40-hour week and maximum 6-day week were retained.

The benefits derived by labor from the code are summarized in the following comparison of employment and earnings in June 1933 and April 1934.

Employment and earnings in iron and steel industry (exclusive of iron-ore mining), June 1933 and April 1934 [1]

	June 1933	April 1934
Grand total, all employees:		
Total number employees	338, 146	431, 086
Total wages and salaries	$30, 560, 761	$45, 471, 878
Average hours per week	39. 7	34. 4
Average earnings per hour	$0. 53	$0. 714
Total hours worked	57, 555, 359	63, 690, 525
Wage earners (employees receiving hourly, tonnage, or piecework rates):		
Number of wage earners	305, 329	392, 069
Total wages	$24, 441, 054	$36, 778, 026
Average hours per week	39. 4	33. 7
Average earnings per hour	$0. 473	$0. 648
Average earnings per week	$18. 64	$21. 84
Total hours worked	51, 645, 321	56, 723, 813

[1] National Recovery Administration, Amendments to Code of Fair Competition for the Iron and Steel Industry as Approved on May 30, 1934, by President Roosevelt: Washington, 1934, p. 6.

In comparing the foregoing figures it should be borne in mind that the industry was operated at 53 percent of ingot capacity in April 1934 as against 46 percent in June 1933.

According to the American Iron and Steel Institute the average number of employees of the steel industry in 1934 was 409,349, the total pay rolls (wages and salaries) were $457,842,517, the average number of hours worked per week by all employees was 30.5, and the average hourly earnings of all employees was 70.2 cents.

Men employed and output per man at iron-ore mines.—Although preliminary and piecemeal data on employment in 1934 at plants making pig iron and steel seem to indicate definite improvement in these branches of the industry over 1933 the complete record now available for 1933 on iron-ore mining illustrates that, following the disastrous 12 months of 1932, the greater activity at the mines resulted in only moderate benefit to the miners. The much larger output of ore in 1933 compared with 1932, for example, was not accompanied by a proportionate increase in employment. In 1932, 12,649 men working 16,427,009 hours were required to produce 9,846,916 gross tons of merchantable ore, equivalent to an average output of 0.599 ton per man-hour. In 1933, however, 15,125 men working only 17,931,479 hours were required to produce 17,553,188 tons of merchantable ore, equivalent to an average output of 0.979 ton per man-hour. Thus, from 1932 to 1933 the total man-hours worked increased only 9.2 percent, while the average output per man-hour increased 63.4 percent and the total merchantable ore production 78.3 percent.

Too much should not be made of the increase in output per worker in 1933 over 1932 for, as was pointed out in the Minerals Yearbook 1934 (p. 323), in 1932 many factors militated against a low man-hour cost of ore. The 1933 figure becomes significant, however, when contrasted with the statistical record for 1923–32, as is done in figure 18, indicating that less human energy was required to produce a ton of ore than in any year during the decade 1923–32. This improved performance in mining iron ore in 1933 compared with the 10-year

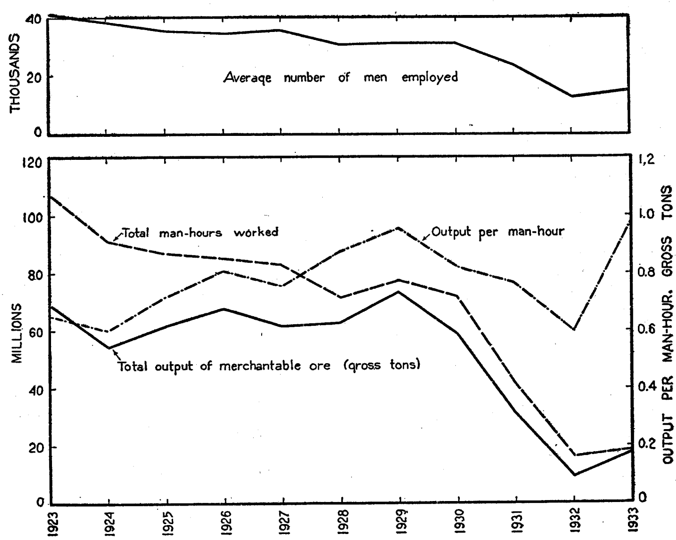

FIGURE 18.—Trends in number of men employed at iron-ore mines, output of merchantable ore, man-hour worked, and output per man-hour in the United States, 1923–33.

period 1923–32 is mainly accounted for by shifts in the source of ore that affect the productivity of the workers. For example, while about three-fourths of the merchantable ore produced in Minnesota during the 10-year period 1923–32 came from open-pit mines, 87 percent was so produced in 1933. The importance of this shift is appreciated when it is recalled that Minnesota produces about three-fifths of the Nation's output and that men at open-pit operations normally show 2½ to 2¾ times the output per man-hour of workers at underground mines. Moreover at the open-pit mines in 1933 an unusually large proportion of the labor force was engaged in the direct mining of ore, as very much less work than usual was done in stripping overburden or in other preparation for future mining.

The higher output per worker in 1933 is especially noteworthy, as most of the mines were still operating on greatly curtailed production schedules, for output was relatively low compared with the average for 1923–29 or even with the depression years 1930 and 1931. Also proportionately more lean ore requiring beneficiation was mined in 1933 than in any year during the period under review. In 1933, for instance, beneficiated ore represented 18.11 percent of the total merchantable ore produced compared with 16.07 percent in 1932 and with an average of 13.78 percent during the period 1923–32.

Only 12,586,959 hours of labor were required to produce 14,611,032 tons of merchantable ore in 1933 in the Lake Superior district (Michigan, Minnesota, and Wisconsin), from which about 85 percent of the iron ore in the United States is mined. This is equivalent to an average output of 1.161 tons per man-hour, whereas 12,638,707 hours were required to produce 8,139,427 tons of ore in 1932, equivalent to an average output of 0.644 ton per man-hour. Thus, from 1932 to 1933 the total man-hours worked decreased 0.41 percent while the

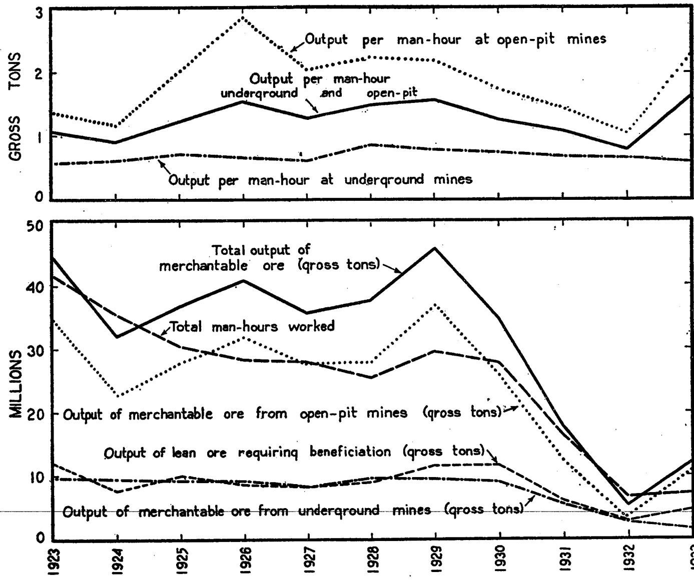

FIGURE 19.—Trends in output of merchantable iron ore per man-hour at open-pit and underground mines in Minnesota, 1923–33, compared with production of merchantable and lean ore and total man-hours worked.

average output per man-hour increased 80.3 percent and the total merchantable ore production 79.5 percent.

This remarkable reduction in the man-hour cost of iron ore in the Lake Superior district in 1933 compared with 1932 was due mainly, as already stated, to a significant shift in production of ore to open-pit mines. In 1933, for example, 73.3 percent of the merchantable ore produced in the Lake Superior district came from open-pit mines, while in 1932 only 38.8 percent was so produced. Another important factor, however, was the stripping of less overburden in 1933 than in 1932. In 1933, for example, only 2,649,802 cubic yards of overburden were stripped from mines in St. Louis and Itasca Counties, Minn., compared with 4,464,797 cubic yards in 1932. On the other hand, 4,639,776 gross tons of lean ore requiring beneficiating were mined in Minnesota in 1933, compared with only 2,477,163 tons in 1932.

Although the output of ore from open-pit mines in the Lake Superior district increased 239 percent in 1933 compared with 1932, the production from underground mines declined 22 percent. This decrease in volume of production at underground mines was accompanied by a reduced output per man-hour, due in part at least to the fact that about the same amount of labor is required regularly for constant dewatering and other maintenance work, so that proportionately more man-hours of labor per unit of product produced are expended in years of poor demand than in years of greater activity.

In the Southeastern district (Alabama, Georgia, North Carolina, Tennessee, and Virginia) the average output of merchantable ore per man-hour increased from 0.464 ton in 1932 to 0.471 ton in 1933. The largest mining units, as well as the most consistent producing mines, are in Jefferson County, Ala., and these mines normally furnish about 85 percent of the total merchantable ore produced in the Southeastern district. In 1933, 2,556 men working 3,965,744 hours produced

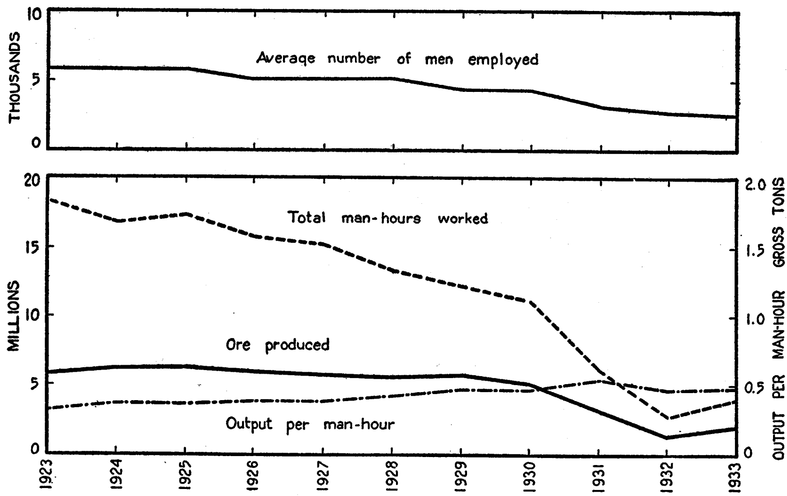

FIGURE 20.—Trends in production, man-hours worked, output per man-hour, and number of men employed at iron-ore mines in Jefferson County, Ala., 1923–33.

1,925,090 tons of ore at mines in Jefferson County, equivalent to an average output of 0.485 ton per man-hour; in 1932, 2,792 men working 2,845,966 hours produced 1,332,975 tons of ore, equivalent to an average output of 0.468 ton per man-hour.

In the Northeastern district (New Jersey, New York, and Pennsylvania) the average output of merchantable ore per man-hour rose from 0.311 ton in 1932 to 0.835 ton in 1933, an increase of 168 percent. This sharp change in the Northeastern district may be explained in part by the production of proportionately more ore from open-pit mines in 1933 than in 1932. In 1933, for instance, 66.6 percent of the total merchantable ore produced in this district came from open-pit mines, while in 1932 only 42.7 percent was so produced. In part, also, it was due to the greatly improved performance reported in 1933 in mining and concentrating ore from the Washington mine.

A significant decrease—from 9 hours in 1932 to 8.5 hours in 1933—is shown in the length of the workday. In the Lake Superior district the average length of the workday declined from 8.9 hours in 1932 to 8.3 hours in 1933, in the Southeastern district from 9.7 hours to 8.9 hours, and in the Northeastern district from 9 hours to 8.2 hours. The iron-ore industry virtually eliminated the longer workday during 1933 in favor of the 8-hour day.

The average number of men employed, as shown in the tables, includes all employees developing and mining iron ore at both open-pit and underground mines, those employed on the surface, and those employed in beneficiating plants; in other words, all men necessary to mine, beneficiate, and load the ore into cars for shipment to consuming plants. The average number of days worked each year and the average man-hours worked per day were calculated from the total man-shifts and from the total man-hours, respectively, worked by all men.

The two following tables, prepared in collaboration with W. W. Adams of the Bureau's Demographical Division, show employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man by districts for 1923–33 and by States for 1932–33. Corresponding statistics by States for the 10-year period 1923–32, as well as other supplementary data, are given in the chapter on Iron Ore, Pig Iron, Ferro-Alloys and Steel in Minerals Yearbook, 1934.

Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, 1923–33, by districts

[Exclusive of ore containing 5 percent or more manganese]

Year	Employment					Production									
	Average number of men employed	Time employed				Crude ore (partly estimated), gross tons	Merchantable ore			Average per man (gross tons)					
		Average number of days	Total man-shifts	Man-hours			Gross tons	Iron (natural) contained		Crude ore (partly estimated)		Merchantable ore			
				Average per day	Total			Gross tons	Percent	Per day	Per hour	Per day	Per hour	Iron (natural) contained: Per day	Iron (natural) contained: Per hour
UNITED STATES															
1923	41, 294	286	11, 797, 682	9. 1	107, 551, 244	80, 669, 623	69, 351, 442	34, 970, 464	50. 42	6. 838	0. 750	5. 878	0. 645	2. 964	0. 325
1924	38, 765	263	10, 201, 678	9. 0	91, 324, 498	61, 458, 841	54, 267, 419	27, 082, 183	49. 91	6. 024	. 673	5. 319	. 594	2. 655	. 297
1925	35, 757	270	9, 665, 877	8. 9	86, 286, 684	70, 474, 965	61, 907, 997	31, 090, 824	50. 22	7. 291	. 817	6. 405	. 717	3. 217	. 360
1926	34, 399	273	9, 395, 178	9. 0	84, 225, 524	75, 943, 775	67, 623, 000	34, 099, 262	50. 43	8. 083	. 902	7. 198	. 803	3. 629	. 405
1927	34, 755	264	9, 177, 979	8. 9	82, 004, 761	69, 923, 057	61, 741, 100	30, 879, 989	50. 02	7. 619	. 853	6. 727	. 753	3, 365	. 377
1928	30, 238	265	8, 008, 647	8. 9	71, 403, 631	70, 940, 916	62, 197, 088	31, 149, 584	50. 08	8. 858	. 994	7. 766	. 871	3. 889	. 436
1929	30, 763	281	8, 638, 234	8. 9	77, 111, 086	83, 164, 881	73, 027, 720	36, 637, 660	50. 17	9. 628	1. 079	8. 454	. 947	4. 241	. 475
1930	30, 975	259	8, 037, 096	8. 9	71, 620, 115	68, 551, 913	58, 408, 664	29, 212, 457	50. 01	8. 529	. 957	7. 267	. 816	3. 635	. 408
1931	22, 867	201	4, 596, 504	8. 9	40, 928, 283	35, 563, 994	31, 131, 502	15, 625, 050	50. 19	7. 737	. 869	6. 773	. 761	3. 399	. 382
1932	12, 649	145	1, 828, 002	9. 0	16, 427, 009	11, 181, 678	9, 846, 916	4, 948, 243	50. 25	6. 117	. 681	5. 387	. 599	2. 707	. 301
1933	15, 125	140	2, 121, 494	8. 5	17, 931, 479	21, 225, 958	17, 553, 188	8, 777, 574	50. 01	10. 005	1. 184	8. 274	. 979	4. 137	. 490
LAKE SUPERIOR															
1923	28, 756	292	8, 397, 782	8. 8	74, 197, 870	63, 737, 822	59, 394, 180	30, 860, 060	51. 96	7. 590	. 859	7. 073	. 800	3. 675	. 416
1924	27, 651	269	7, 449, 720	8. 7	64, 679, 800	47, 561, 165	44, 942, 898	23, 351, 488	51. 96	6. 384	. 735	6. 033	. 695	3. 135	. 361
1925	25, 472	268	6, 837, 245	8. 6	58, 916, 445	55, 569, 424	52, 163, 922	27, 160, 188	52. 07	8. 127	. 943	7. 629	. 885	3. 972	. 461
1926	24, 483	271	6, 645, 613	8. 6	57, 094, 412	60, 410, 352	57, 272, 643	29, 737, 718	51. 92	9. 090	1. 058	8. 618	1. 003	4. 475	. 521
1927	24, 904	258	6, 424, 947	8. 6	55, 268, 641	54, 744, 797	51, 627, 335	26, 647, 001	51. 61	8. 521	. 991	8. 035	. 934	4. 147	. 482
1928	20, 881	266	5, 562, 599	8. 6	47, 996, 087	56, 059, 314	52, 525, 581	27, 061, 370	51. 52	10. 078	1. 168	9. 443	1. 094	4. 865	. 564
1929	21, 811	286	6, 243, 609	8. 7	54, 615, 027	67, 609, 545	62, 825, 826	32, 294, 527	51. 40	10. 829	1. 238	10. 062	1. 150	5. 172	. 591
1930	22, 301	261	5, 823, 736	8. 8	51, 197, 616	54, 323, 659	49, 383, 385	25, 295, 164	51. 22	9. 328	1. 061	8. 480	. 965	4. 343	. 494
1931	16, 487	207	3, 404, 984	8. 8	30, 017, 397	28, 188, 521	25, 877, 416	13, 408, 123	51. 81	8. 279	. 939	7. 600	. 862	3. 938	. 447
1932	8, 768	163	1, 427, 926	8. 9	12, 638, 707	9, 160, 742	8, 139, 427	4, 267, 074	52. 42	6. 415	. 725	5. 700	. 644	2. 988	. 338
1933	11, 598	130	1, 512, 172	8. 3	12, 586, 959	16, 608, 574	14, 611, 032	7, 571, 079	51. 82	10. 983	1. 320	9. 662	1. 161	5. 007	. 602

SOUTHEASTERN															
1923	9,220	286	2,633,776	10.2	26,836,560	13,866,000	7,383,403	2,771,682	37.54	5.265	.517	2.803	.275	1.052	.103
1924	8,428	267	2,254,179	9.9	22,394,244	11,791,000	7,388,822	2,742,748	37.12	5.231	.527	3.278	.330	1.217	.122
1925	7,995	287	2,295,030	10.0	22,860,533	12,395,000	7,455,085	2,783,059	37.33	5.401	.542	3.248	.326	1.213	.122
1926	6,992	285	1,989,600	10.4	20,608,685	11,674,198	7,102,607	2,659,468	37.44	5.868	.566	3.570	.345	1.337	.129
1927	6,737	271	1,825,168	10.3	18,872,054	10,965,528	6,714,810	2,498,225	37.20	6.008	.581	3.679	.356	1.369	.132
1928	6,383	259	1,654,319	10.2	16,827,784	11,281,000	6,537,726	2,451,191	37.49	6.819	.670	3.952	.389	1.482	.146
1929	5,917	260	1,541,248	10.0	15,391,042	11,138,675	6,645,237	2,497,520	37.58	7.227	.724	4.312	.432	1.620	.162
1930	5,303	254	1,347,721	9.8	13,145,780	10,039,100	5,838,105	2,196,940	37.63	7.449	.764	4.332	.444	1.630	.167
1931	3,752	195	731,303	9.6	7,011,326	5,364,000	3,644,606	1,359,470	37.30	7.335	.765	4.984	.520	1.859	.194
1932	2,891	106	305,489	9.7	2,964,520	1,634,925	1,375,459	514,142	37.40	5.352	.551	4.502	.464	1.683	.173
1933	3,025	171	515,862	8.9	4,583,196	3,785,589	2,159,958	811,077	37.55	7.338	.826	4.187	.471	1.572	.177
NORTHEASTERN															
1923	2,418	220	531,780	8.7	4,634,464	2,277,701	1,843,096	946,525	51.36	4.283	.491	3.466	.398	1.780	.204
1924	1,790	151	270,748	8.9	2,414,316	1,253,305	1,128,481	549,179	48.67	4.629	.519	4.168	.467	2.028	.227
1925	1,519	222	337,770	8.7	2,949,278	1,521,014	1,302,841	612,835	47.04	4.503	.516	3.857	.442	1.814	.208
1926	2,077	250	519,808	8.8	4,594,321	2,395,664	1,943,471	997,575	51.33	4.609	.521	3.739	.423	1.919	.217
1927	2,213	293	649,069	8.7	5,633,706	2,984,673	2,244,254	1,124,976	50.13	4.598	.530	3.458	.398	1.733	.200
1928	1,977	244	482,305	8.5	4,093,401	2,381,804	1,986,959	1,034,908	52.09	4.938	.582	4.120	.485	2.146	.253
1929	2,097	269	563,692	8.5	4,787,157	2,843,595	2,195,601	1,140,708	51.95	5.045	.594	3.895	.459	2.024	.238
1930	2,731	262	714,189	8.5	6,058,999	3,107,185	2,248,682	1,238,005	55.05	4.351	.513	3.149	.371	1.733	.204
1931	1,688	175	295,217	8.7	2,570,050	1,224,797	936,960	509,590	54.39	4.149	.477	3.174	.365	1.726	.198
1932	585	101	58,906	9.0	530,682	218,990	165,009	78,960	47.85	3.718	.413	2.801	.311	1.340	.149
1933	310	186	57,625	8.2	474,644	445,825	396,228	190,213	48.01	7.737	.939	6.876	.835	3.301	.401
WESTERN															
1923	900	260	234,344	8.0	1,882,350	788,100	730,763	392,197	53.67	3.363	.419	3.118	.388	1.674	.208
1924	896	253	227,031	8.1	1,836,138	853,371	807,218	438,768	54.36	3.759	.465	3.556	.440	1.933	.239
1925	771	254	195,832	8.0	1,560,428	989,527	986,149	534,742	54.23	5.053	.634	5.036	.632	2.731	.343
1926	847	284	240,157	8.0	1,928,106	1,463,561	1,304,279	704,501	54.01	6.094	.759	5.431	.676	2.934	.365
1927	901	309	278,795	8.0	2,230,360	1,228,059	1,154,701	609,787	52.81	4.405	.551	4.142	.518	2.187	.273
1928	997	310	309,424	8.0	2,486,359	1,218,798	1,146,822	602,115	52.50	3.939	.490	3.706	.461	1.946	.242
1929	938	309	289,685	8.0	2,317,860	1,573,066	1,361,056	704,905	51.79	5.430	.679	4.698	.587	2.433	.304
1930	640	237	151,450	8.0	1,217,720	1,081,969	938,492	482,348	51.40	7.144	.889	6.197	.771	3.185	.396
1931	940	176	165,000	8.1	1,329,510	786,676	672,520	347,867	51.73	4.768	.592	4.076	.506	2.108	.262
1932	405	88	35,681	8.2	293,100	167,021	167,021	88,067	52.73	4.681	.570	4.681	.570	2.468	.300
1933	192	187	35,835	8.0	286,680	385,970	385,970	205,205	53.17	10.771	1.346	10.771	1.346	5.726	.716

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Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man, 1932–33, by districts and States

[Exclusive of ore containing 5 percent or more manganese]

District and State	Employment					Production									
	Average number of men employed	Time employed				Crude ore (partly estimated), gross tons	Merchantable ore			Average per man (gross tons)					
		Average number of days	Total man-shifts	Man-hours			Gross tons	Iron (natural) contained		Crude ore (partly estimated)		Merchantable ore			
				Average per day	Total			Gross tons	Percent	Per day	Per hour	Per day	Per hour	Iron (natural) contained	
														Per day	Per hour
1932															
Lake Superior:															
Michigan	4, 697	139	651, 822	8. 5	5, 559, 864	2, 554, 996	2, 554, 996	1, 322, 650	51. 77	3. 920	0. 460	3. 920	0. 460	2. 029	0. 238
Minnesota	3, 683	191	703, 304	9. 2	6, 462, 204	6, 175, 606	5, 154, 291	2, 713, 988	52. 65	8. 781	. 956	7. 329	. 798	3. 859	. 420
Wisconsin	388	188	72, 800	8. 5	616, 639	430, 140	430, 140	230, 436	53. 57	5. 909	. 698	5. 909	. 698	3. 165	. 374
	8, 768	163	1, 427, 926	8. 9	12, 638, 707	9, 160, 742	8, 139, 427	4, 267, 074	52. 42	6. 415	. 725	5. 700	. 644	2. 988	. 338
Southeastern:															
Alabama	} 2, 891	106	305, 489	9. 7	2, 964, 520	{ 1, 634, 000	1, 374, 534	513, 722	37. 37	} 5. 352	. 551	4. 502	. 464	1. 683	. 173
Georgia						925	925	420	45. 41						
	2, 891	106	305, 489	9. 7	2, 964, 520	1, 634, 925	1, 375, 459	514, 142	37. 40	5. 352	. 551	4. 502	. 464	1. 683	. 173
Northeastern:															
New Jersey	} 585	101	58, 906	9. 0	530, 682	{ 43, 535	30, 844	18, 790	60. 92	} 3. 718	. 413	2. 801	. 311	1. 340	. 149
New York						72, 567	31, 327	21, 187	67. 63						
Pennsylvania						102, 888	102, 838	38, 983	37. 91						
	585	101	58, 906	9. 0	530, 682	218, 990	165, 009	78, 960	47. 85	3. 718	. 413	2. 801	. 311	1. 340	. 149

Western:																
Missouri	401	88	35, 256	8. 2	289, 700	29, 797	29, 797	15, 931	53. 47	4. 681	. 570	4. 681	. 570	2. 468	. 300
Utah						137, 224	137, 224	72, 136	52. 57						
Montana	1	25	25	8. 0	200	----------	----------	----------	--------						
Washington	1	150	150	8. 0	1, 200	----------	----------	----------	--------						
Wyoming	2	125	250	8. 0	2, 000	----------	----------	----------	--------						
	405	88	35, 681	8. 2	293, 100	167, 021	167, 021	88, 067	52. 73	4. 681	. 570	4. 681	. 570	2. 468	. 300
	12, 649	145	1, 828, 002	9. 0	16, 427, 009	11, 181, 678	9, 846, 916	4, 948, 243	50. 25	6. 117	. 681	5. 387	. 599	2. 707	. 301
1933															
Lake Superior:															
Michigan	4, 822	121	583, 896	8. 3	4, 832, 064	2, 433, 949	2, 433, 949	1, 254, 603	51. 55	4. 168	. 504	4. 168	. 504	2. 149	. 260
Minnesota	6, 549	133	872, 188	8. 4	7, 283, 050	13, 946, 138	11, 948, 596	6, 194, 413	51. 84	15. 990	1. 915	13. 700	1. 641	7. 102	. 851
Wisconsin	227	247	56, 088	8. 4	471, 845	228, 487	228, 487	122, 063	53. 42	4. 074	. 484	4. 074	. 484	2. 176	. 259
	11, 598	130	1, 512, 172	8. 3	12, 586, 959	16, 608, 574	14, 611, 032	7, 571, 079	51. 82	10. 983	1. 320	9. 662	1. 161	5. 007	. 602
Southeastern:															
Alabama	2, 940	171	504, 146	8. 9	4, 485, 588	3, 749, 000	2, 133, 457	799, 099	37. 46	7. 436	. 836	4. 232	. 476	1. 585	. 178
Georgia	85	138	11, 716	8. 3	97, 608	36, 589	1, 302	587	45. 00	3. 123	. 375	2. 262	. 272	1. 022	. 123
Tennessee							24, 912	11, 262	45. 21						
Virginia							287	129	45. 00						
	3, 025	171	515, 862	8. 9	4, 583, 196	3, 785, 589	2, 159, 958	811, 077	37. 55	7. 338	. 826	4. 187	. 471	1. 572	. 177
Northeastern:															
New Jersey	310	186	57, 625	8. 2	474, 644	80, 180	73, 144	44, 742	61. 17	7. 737	. 939	6. 876	. 835	3. 301	. 401
New York						101, 150	58, 718	40, 369	68. 75						
Pennsylvania						264, 495	264, 366	105, 102	39. 76						
	310	186	57, 625	8. 2	474, 644	445, 825	396, 228	190, 213	48. 01	7. 737	. 939	6. 876	. 835	3. 301	. 401
Western:															
California	65	228	14, 826	8. 0	118, 608	25	25	11	42. 00	6. 565	. 821	6. 565	. 821	3. 441	. 430
Missouri						395	395	264	66. 74						
Utah						95, 279	95, 279	49, 746	52. 21						
Washington						1, 631	1, 631	993	60. 85						
Wyoming	127	165	21, 009	8. 0	168, 072	288, 640	288, 640	154, 191	53. 42	13. 739	1. 717	13. 739	1. 717	7. 339	. 917
	192	187	35, 835	8. 0	286, 680	385, 970	385, 970	205, 205	53. 17	10. 771	1. 346	10. 771	1. 346	5. 726	. 716
	15, 125	140	2, 121, 494	8. 5	17, 931, 479	21, 225, 958	17, 553, 188	8, 777, 574	50. 01	10. 005	1. 184	8. 274	. 979	4. 137	. 490

IRON ORE

Production and shipments.—Iron ore was mined at 141 mines in 15 States in 1934, compared with 132 mines in 15 States in 1933. In 1934, 4 iron-ore mines produced a million tons or more each, and 69 had an output of 100,000 tons or more, whereas in 1933, 2 mines produced a million tons or more and 47 yielded 100,000 tons or more. The production of iron ore in 1934 was 24,587,616 gross tons, an increase of 40 percent over 1933 but 57 percent below the average for the 5-year period 1927–31. Shipments of iron ore were 25,792,606 gross tons in 1934, an increase of 5 percent over 1933 but 55 percent below the average for 1927–31. The greater part of the iron ore mined in the United States is used in the manufacture of iron and steel; but 33,303 tons of the ore produced in 1934 was used in making paint (5,346 tons), cement (23,943 tons), and ferromagnesite (1,920 tons) and for purifying gas (864 tons), hydrogen gas (297 tons), concrete aggregate (550 tons), and flux at nonferrous smelters (383 tons).

In the following tables the quantities of iron ore shown include ore that was beneficiated—that is, treated in any way—as well as ore that does not require treatment. Although included in the figures on production the iron ore sold for the manufacture of paint (5,346 gross tons in 1934 valued at $26,151—$4.89 a ton—compared with 1,125 gross tons in 1933 valued at $8,435—$7.50 a ton) is not included in the figures on shipments from mines. The output of manganiferous ore that contained 5 percent or more manganese also is not included; 221,822 gross tons valued at $621,090 were shipped in 1934 compared with 191,631 gross tons valued at $529,204 in 1933. In Arkansas one producer shipped 5 gross tons of loadstone, which is not included in the tabulated statistics of iron ore. Neither do the statistics include iron sinter recovered from copper sulphide ore mined in Tennessee.

Iron ore mined in the United States in 1934, by States and varieties, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	Number of active mines	Hematite	Brown ore	Magnetite	Carbonate	Total
Alabama	[1] 21	2,065,915	277,904			2,343,819
California	2	15,783		550		16,333
Georgia	2		164			164
Michigan	35	5,039,144				5,039,144
Minnesota	57	15,389,870				15,389,870
Missouri	5	400	3,704			4,104
New Jersey	2			138,685		138,685
New York	4	(2)		[2] 244,962		244,962
Pennsylvania	3		864	523,793	640	525,297
Tennessee	2	305	3,040			3,345
Utah	2	161,009	100			161,109
Virginia	1		297			297
Washington	1			1,920		1,920
Wisconsin	3	602,005				602,005
Wyoming	1	116,562				116,562
Total, 1934	[1] 141	[2] 23,390,993	286,073	[2] 909,910	640	24,587,616
Total, 1933	132	16,920,672	235,297	396,720	499	17,553,188

[1] In addition, a small but undetermined number of surface mines were worked in Alabama. The output from these mines is included in the figures given.
[2] Some hematite included with magnetite.

Iron ore mined in the United States, 1932–34, by States and mining methods, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	Open pit	Underground	Undistributed	Total
1932				
Alabama	41,559	1,332,975		1,374,534
Georgia	925			925
Michigan	[1] 235,248	[1] 2,319,748		2,554,996
Minnesota	2,921,484	2,232,807		5,154,291
Missouri	26,947	2,093	757	29,797
New Jersey		30,844		30,844
New York		31,327		31,327
Pennsylvania	70,406	32,432		102,838
Utah	136,874	350		137,224
Wisconsin		430,140		430,140
	[1] 3,433,443	[1] 6,412,716	757	9,846,916
1933				
Alabama	208,367	1,925,090		2,133,457
California	25			25
Georgia	1,302			1,302
Michigan	[1] 304,453	[1] 2,129,496		2,433,949
Minnesota	10,405,709	1,542,887		11,948,596
Missouri	395			395
New Jersey		73,144		73,144
New York		58,718		58,718
Pennsylvania	263,814	552		264,366
Tennessee	24,912			24,912
Utah	95,129	150		95,279
Virginia	287			287
Washington	1,631			1,631
Wisconsin		228,487		228,487
Wyoming	29,785	258,855		288,640
	[1] 11,335,809	[1] 6,217,379		17,553,188
1934				
Alabama	293,904	2,049,915		2,343,819
California	16,333			16,333
Georgia	164			164
Michigan	647,959	4,391,185		5,039,144
Minnesota	12,308,109	3,081,761		15,389,870
Missouri	3,704	400		4,104
New Jersey		138,685		138,685
New York	(2)	[2] 244,962		244,962
Pennsylvania	524,657	640		525,297
Tennessee	3,345			3,345
Utah	161,009	100		161,109
Virginia	297			297
Washington	1,920			1,920
Wisconsin	263	601,742		602,005
Wyoming	92,753	23,809		116,562
	[2] 14,054,417	[2] 10,533,199		24,587,616

[1] Revised figures. [2] Some open pit included with underground.

Iron ore mined in the United States, 1933–34, by States and counties

[Exclusive of ore containing 5 percent or more manganese]

State and county	1933		1934	
	Active mines	Gross tons	Active mines	Gross tons
Alabama:				
Blount	2	89,782	3	136,145
Butler	2	4,982	1	19,799
Cherokee	1	12,137	3	1,280
Etowah	1	386	1	16,000
Franklin	2	64,770	[1] 2	64,501
Jefferson	5	1,925,090	5	2,049,915
Shelby	1	26,090	1	39,180
Talladega	4	7,525	3	16,429
Tuscaloosa	1	2,695	2	570
	19	2,133,457	[1] 21	2,343,819

[1] In addition, a small but undetermined number of surface mines were worked in Franklin County, Ala. The output from these mines is included in the figures given.

Iron ore mined in the United States, 1933–34, by States and counties—Continued

State and county	1933 Active mines	1933 Gross tons	1934 Active mines	1934 Gross tons
California:				
Alameda	1	25		
San Bernardino			1	15,783
Santa Cruz			1	550
	1	25	2	16,333
Georgia:				
Bartow			1	35
Floyd	1	302		
Polk	1	1,000	1	129
	2	1,302	2	164
Michigan:				
Dickinson	1	69,170	3	157,322
Gogebic	10	880,837	10	1,850,312
Iron	13	492,338	8	700,734
Marquette	13	991,604	14	2,330,776
	37	2,433,949	35	5,039,144
Minnesota:				
Crow Wing	4	279,997	3	192,031
Itasca	16	3,053,634	15	3,318,021
St. Louis	38	8,614,965	39	11,879,818
	58	11,948,596	57	15,389,870
Missouri:				
Bollinger			2	468
Dent			1	400
Howell			1	200
Madison			1	3,036
St. Francois	1	395		
	1	395	5	4,104
New Jersey:				
Morris			1	84,302
Warren	1	73,144	1	54,383
	1	73,144	2	138,685
New York:				
Essex			1	142,226
Clinton	1	58,718	1	} 102,736
Oneida			1	}
Wayne			1	}
	1	58,718	4	244,962
Pennsylvania:				
Carbon	1	499	1	640
Clearfield			1	864
Lebanon	1	263,227	1	523,793
Venango	1	640		
	3	264,366	3	525,297
Tennessee:				
Franklin			1	305
Hickman	1	20,912		
Lawrence	1	4,000	1	3,040
	2	24,912	2	3,345
Utah:				
Box Elder	1	150	1	100
Iron	1	95,129	1	161,009
	2	95,279	2	161,109
Virginia: Botetourt	1	287	1	297
Washington: Stevens	1	1,631	1	1,920
Wisconsin:				
Dodge			1	263
Iron	2	228,487	2	601,742
	2	228,487	3	602,005
Wyoming: Platte	1	288,640	1	116,562
	132	17,553,188	[1] 141	24,587,616

[1] In addition, a small but undetermined number of surface mines were worked in Franklin County, Ala. The output from these mines is included in the figures given.

Iron ore mined in the United States, by mining districts and varieties, in 1934, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

District	Hematite	Brown ore	Magnetite	Carbonate	Total
Lake Superior [1]	21,030,756				21,030,756
Birmingham	2,049,915	175,895			2,225,810
Chattanooga	16,305	17,873			34,178
Adirondack			[2] 244,962		[2] 244,962
Northern New Jersey and southeastern New York			138,685		138,685
Other districts	[2] 294,017	92,305	526,263	640	[2] 913,225
Total, 1934	[2] 23,390,993	286,073	[2] 909,910	640	24,587,616
Total, 1933	16,920,672	235,297	396,720	499	17,553,188

[1] Includes only those mines in Wisconsin that are in the true Lake Superior district.
[2] Some hematite from "Other districts" included with magnetite from Adirondack district.

Quantity and tenor of iron ore mined in the United States, 1933–34

[Exclusive of ore containing 5 percent or more manganese]

State	1933		1934	
	Gross tons	Iron content (natural)	Gross tons	Iron content (natural)
		Percent		*Percent*
Alabama	2,133,457	37.46	2,343,819	37.61
California	25	42.00	16,333	58.98
Michigan	2,433,949	51.55	5,039,144	51.84
Minnesota	11,948,596	51.84	15,389,870	51.63
Missouri	395	66.74	4,104	49.17
New Jersey	73,144	61.17	138,685	58.33
New York	58,718	68.75	244,962	67.62
Pennsylvania	264,366	39.76	525,297	40.50
Tennessee	24,912	45.21	3,345	43.56
Utah	95,279	52.21	161,109	52.30
Wisconsin	228,487	53.42	602,005	53.57
Wyoming	288,640	53.42	116,562	55.20
Georgia	1,302	45.00	164	57.87
Virginia	287	45.00	297	
Washington	1,631	60.85	1,920	
	17,553,188	50.01	24,587,616	50.37

Iron ore shipped from mines in the United States, 1933–34, by States

[Exclusive of ore containing 5 percent or more manganese and ore sold for paint]

State	1933		1934	
	Gross tons	Value	Gross tons	Value
Alabama	2,156,142	$3,252,630	2,720,923	$4,379,827
California			16,333	(1)
Georgia	302	(1)	1,098	(1)
Michigan	6,099,031	18,442,073	5,497,953	15,646,165
Minnesota	14,784,763	38,291,656	15,768,418	41,843,148
Missouri			4,154	13,271
New Jersey	73,385	(1)	145,326	(1)
New York	163,000	(1)	235,025	(1)
Pennsylvania	324,052	650,664	524,657	1,052,770
Tennessee	24,912	47,824	3,040	6,080
Utah	95,129	(1)	161,009	(1)
Virginia	287	574	297	594
Washington	1,631	(1)	1,920	(1)
Wisconsin	613,011	1,646,076	595,891	1,565,958
Wyoming	288,640	(1)	116,562	(1)
Undistributed		[2] 1,444,536		[2] 1,976,033
	24,624,285	63,776,033	25,792,606	66,483,846

[1] Included under "Undistributed." [2] This figure includes value for States entered as "(1)" above.

Principal iron-ore mines.—In 1934, 69 iron-ore mines produced more than 100,000 gross tons each compared with 47 in 1933. Of these 69 mines, 4 (3 in Minnesota and 1 in Alabama) produced more than 1,000,000 tons each, compared with 2 (both in Minnesota) in 1933. The predominance of hematite as an iron ore is shown clearly by the fact that of these 69 mines, 65 produced hematite, 3 produced magnetite, and 1 produced brown ore. The importance of large mining units is shown in the production of 90 percent of the output of the country by the 69 mines which yielded more than 100,000 tons each.

Iron-ore mines of the United States (arranged in order of rank) that produced more than 100,000 gross tons each in 1934

[All mines produced hematite except Chateaugay, Cornwall, and Witherbee Sherman Corporation group which produced magnetite, and Champion Nos. 1 and 3, which produced brown ore]

Name of mine	State	Nearest town	Gross tons
Hartley-Burt	Minnesota	Chisholm	2,000,942
Adams-Spruce group	do	Eveleth	1,347,960
Red Mountain group	Alabama	Bessemer	1,177,419
Sellers	Minnesota	Hibbing	1,170,416
Mahoning	do	do	857,570
Mesabi Chief	do	Nashwauk	716,032
Montreal	Wisconsin	Montreal	579,965
Morrison	Minnesota	Coleraine	575,861
Minnewas	do	Virginia	555,693
Dunwoody	do	Chisholm	533,607
Cornwall	Pennsylvania	Miners Village	523,793
Leonidas	Minnesota	Eveleth	516,511
Hill Annex	do	Calumet	496,804
Missabe Mountain	do	Virginia	448,800
Canisteo	do	Coleraine	430,142
Pioneer	do	Ely	421,228
Newport	Michigan	Ironwood	399,390
Ironton	do	Bessemer	373,100
Godfrey-Wellington	Minnesota	Chisholm	341,384
Biwabik	do	Biwabik	327,330
Susquehanna	do	Hibbing	302,491
Woodward No. 3	Alabama	Bessemer	296,220
Blueberry	Michigan	Ishpeming	282,532
Scranton	Minnesota	Hibbing	282,416
Maas	Michigan	Negaunee	279,085
Sloss Nos. 1 and 2	Alabama	Bessemer	275,631
Alexandria	Minnesota	Hibbing	243,917
Negaunee	Michigan	Negaunee	235,664
Cliffs Shaft	do	Ishpeming	223,245
Burt-Pool-Day	Minnesota	Hibbing	215,938
Wakefield	Michigan	Wakefield	204,129
Hiawatha	do	Iron River	199,457
Asteroid-Eureka	do	Ramsay	193,560
St. Paul	Minnesota	Keewatin	181,621
Puritan	Michigan	Ironwood	179,029
Shenango	Minnesota	Chisholm	176,078
Hull-Rust	do	Hibbing	175,154
Sunday Lake	Michigan	Wakefield	173,513
Morris	do	Ishpeming	173,268
Halobe	Minnesota	Cooley	173,018
Volunteer	Michigan	Palmer	172,885
Raimund Nos. 1 and 2	Alabama	Bessemer	172,736
Morris	Minnesota	Hibbing	169,821
Tilden (including Ogden)	Michigan	Ishpeming	167,688
Bates	do	Iron River	167,064
Webb	Minnesota	Hibbing	165,573
Athens	Michigan	Negaunee	162,706
Margaret	Minnesota	Buhl	161,405
Cambria-Lillie	Michigan	Negaunee	161,302
Desert Mound	Utah	Iron Springs	161,009
Sargent	Minnesota	Keewatin	147,739
Witherbee Sherman Corporation group	New York	Mineville	142,226
Kinney	Minnesota	Kinney	140,645
Norrie-Aurora	Michigan	Ironwood	137,982
Penn group	do	Vulcan	130,297
Lake Superior-Holmes	do	Ishpeming	129,687
Spaulding	Alabama	Birmingham	127,909
Zenith	Minnesota	Ely	126,276
Lloyd	Michigan	Ishpeming	123,771
Sibley	Minnesota	Ely	120,657

Iron-ore mines of the United States (arranged in order of rank) that produced more than 100,000 gross tons each in 1934—Continued

Name of mine	State	Nearest town	Gross tons
Sunrise	Wyoming	Sunrise	116,562
Hawkins	Minnesota	Nashwauk	114,949
Soudan	do	Soudan	114,431
Champion Nos. 1 and 3	Alabama	Champion	113,348
La Rue	Minnesota	Nashwauk	110,490
West Davis	Michigan	Ironwood	109,144
Drew	Minnesota	Buhl	103,531
Bruce	do	Chisholm	101,103
Chateaugay	New York	Lyon Mountain	100,637
Total (69 mines)			22,233,477
Output of 23 mines producing between 50,000 and 100,000 tons each			1,732,332
Output of 49 mines [1] producing less than 50,000 tons each			621,807
Grand total of United States (141 mines [1])			24,587,616

[1] In addition, a small but undetermined number of surface mines were worked in Alabama. The output from these mines is included in the figures given.

Beneficiated iron ore.—Beneficiation of iron ore was reported at 37 mines in 8 States in 1934 and at 32 mines in 7 States in 1933. At many mines the ore is crushed and screened to improve its structure; ore so improved, however, is not included in the statistics of beneficiated ore. Some iron ore is recovered in the form of dust from blast furnaces, but no statistics on it have been gathered; ore so recovered, however, has been included originally in the statistics of shipments from the mines.

Beneficiated ore shipped from mines in the United States in 1934 amounted to 4,145,590 gross tons valued at $11,527,252 compared with 3,555,892 tons valued at $9,370,879 in 1933.

The quantity of crude ore beneficiated in the Lake Superior district in 1934 totaled 4,858,984 gross tons and the beneficiated ore recovered to 3,022,102—a ratio of 1.608:1. In 1933 the crude ore treated amounted to 4,639,776 tons and the beneficiated ore recovered therefrom 2,642,234 tons—a ratio of 1.756:1.

Beneficiated iron ore shipped from mines in the United States, 1933–34

[Exclusive of ore containing 5 percent or more manganese and of ore sold for paint]

State	Variety	1933		1934	
		Gross tons	Value	Gross tons	Value
Alabama	Brown ore	183,128	$381,074	213,091	$504,575
California	Magnetite			550	(1)
Michigan	Hematite	2,217	(1)		
Minnesota	do	2,908,922	7,404,861	3,245,788	8,569,227
New Jersey	Magnetite	73,385	(1)	145,326	(1)
New York	do	163,000	(1)	235,025	(1)
Pennsylvania	do	200,041	600,123	302,473	907,419
Tennessee	Brown ore	24,912	47,824	3,040	6,080
Virginia	do	287	574	297	594
Undistributed			[2] 936,423		[2] 1,539,357
		3,555,892	9,370,879	4,145,590	11,527,252

[1] Included under "Undistributed."
[2] This figure includes value for States entered as (1) above.

The accompanying table gives the shipments of beneficiated iron ore and the percentage of beneficiated ore to the total ore shipped for 1925–34. Corresponding figures for 1914 (the first year for which statistics were gathered) to 1924 are given in Mineral Resources for 1930.

Iron ore shipped from mines in the United States, 1925–34, in gross tons, and percentage of beneficiated ore compared to the total shipped

[Exclusive of ore containing 5 percent or more manganese and of ore sold for paint]

Year	Beneficiated	Total	Percentage of beneficiated to total	Year	Beneficiated	Total	Percentage of beneficiated to total
1925–29 (average)	8, 653, 590	66, 697, 126	13. 0	1932	407, 486	5, 331, 201	7. 6
1930	8, 973, 888	55, 201, 221	16. 3	1933	3, 555, 892	24, 624, 285	14. 4
1931	4, 676, 364	28, 516, 032	16. 4	1934	4, 145, 590	25, 792, 606	16. 1

Average value of ore.—The average value per ton of iron ore at the mines in 1934 was $2.58 compared with $2.59 in 1933.

The table that follows gives the average value at the mines of the different classes of iron ore in 1933–34 for each of the producing States or groups of States, except where there were less than three shippers of a certain variety of ore in a State and permission was not given to publish the value. These figures are taken directly from statements of producers and probably represent the commercial selling prices only approximately, as not all the reports are comparable. Some of them evidently include mining costs only; others contain, in addition, the cost of selling and insuring the ore; others include an allowance for a sinking fund; and still others include only the costs charged against the blast furnaces. None of the reports, however, is supposed to include freight charges.

Average value per gross ton of iron ore at mines in the United States, 1933–34

[Exclusive of ore containing 5 percent or more manganese and of ore sold for paint]

State	Hematite		Brown ore		Magnetite	
	1933	1934	1933	1934	1933	1934
Alabama	$1. 45	$1. 53	$2. 08	$2. 38		
Michigan	3. 02	2. 85				
Minnesota	2. 59	2. 65				
Missouri		5. 52		2. 91		
Pennsylvania			(1)	(1)	$2. 00	$2. 00
Tennessee			1. 92	2. 00		
Virginia			2. 00	2. 00		
Wisconsin	2. 69	2. 63				
Other States [2]	1. 31	1. 43	1. 87	1. 68	3. 96	4. 06
	2. 59	2. 57	2. 08	2. 39	2. 83	2. 87

[1] Less than 3 producers; permission to publish not given, therefore value may not be shown.
[2] 1933: Georgia, New Jersey, New York, Utah, Washington, and Wyoming; 1934: California, Georgia, New Jersey, New York, Utah, Washington, and Wyoming.

Iron ore consumed.—The production of 15,686,442 gross tons of pig iron in 1934 required 26,488,448 gross tons of iron and manganiferous iron ores and 3,182,588 tons of cinder, scale, and scrap, an average of 1.892 tons of metalliferous materials per ton of iron made.

The greater part of the iron ore used in Alabama furnaces in 1934 was hematite, chiefly from mines in Jefferson County, but some came from Etowah County, Ala. Considerable brown ore and small quantities of ferruginous manganese ore, iron sinter, and imported iron ore also were used. The brown ore was chiefly from mines in the Birmingham and Russellville districts, Alabama; the ferruginous manganese ore was chiefly from mines in Alabama, Arkansas, and Georgia; and the iron sinter was from Tennessee. In 1934 Alabama furnaces consumed an average of 2.364 tons of ore in making 1 ton of pig iron, the highest average for any State.

In 1934 Maryland furnaces used foreign ores obtained from Australia, Chile, Cuba, Spain, Sweden, and U. S. S. R. (Russia). These furnaces consumed an average of only 1.38 tons of ore in making 1 ton of pig iron in 1934; however, they used proportionately more cinder, scale, and scrap than the furnaces in any other State except Kentucky.

The blast furnaces in Illinois, Indiana, Kentucky, Michigan, Ohio, and West Virginia used Lake Superior iron ore and manganiferous iron ore exclusively in 1934. The consumption of ores per ton of iron made in this group of States ranged from 1.254 tons in Kentucky to 1.728 tons in Indiana.

In New York the furnaces in the Buffalo district used ores from the Lake Superior district; the furnaces at Port Henry used magnetite from the mines at Mineville, N. Y.; the furnace at Standish used magnetite from the Chateaugay mine at Lyon Mountain, N. Y., and small quantities of ferruginous manganese ore from the Lake Superior district and of manganese sinter from Cuba; and the furnace at Troy used chiefly magnetite from the mines at Mineville, N. Y., and small quantities of hematite from the Lake Superior district and of manganese-bearing material from New Jersey. In making 1 ton of pig iron the furnaces in New York used an average of 1.682 tons of ore in 1934.

The furnaces in western Pennsylvania used ore from the Lake Superior district. Those in the eastern part of the State used some lake ores, magnetite from mines in New Jersey, New York, and Pennsylvania, and considerable quantities of ores from Africa, Australia, Brazil, Chile, Cuba, India, Spain, Sweden, and U. S. S. R. (Russia). An average of 1.647 tons of ore was used to make 1 ton of pig iron in Pennsylvania in 1934.

The blast furnaces at Pueblo, Colo., used hematite from the Sunrise mine in Wyoming and rhodochrosite from the Emma mine in Montana.

The blast furnace at Provo, Utah, used iron ore chiefly from the Desert Mound mine in the Iron Springs district, Utah. The manganiferous iron ore used was obtained chiefly from Montana.

Iron ore and other metallic materials consumed and pig iron produced in 1934, by States, in gross tons

State	Metalliferous materials consumed				Pig iron produced, exclusive of ferroalloys	Materials consumed per ton of iron made		
	Iron and manganiferous iron ores		Cinder, scale, and scrap	Total		Ores	Cinder, scale, and scrap	Total
	Domestic	Foreign						
Alabama	2,760,187	10,377	106,378	2,876,942	1,171,650	2.364	0.091	2.455
Illinois	2,058,098		227,751	2,285,849	1,269,154	1.622	.179	1.801
Indiana	2,701,482		355,390	3,056,872	1,563,350	1.728	.227	1.955
Kentucky	212,308		75,485	287,793	169,290	1.254	.446	1.700
Maryland		972,555	230,630	1,203,185	704,850	1.380	.327	1.707
Michigan	959,396		128,866	1,088,262	621,187	1.545	.207	1.752
New York	1,787,989	14	157,748	1,945,751	1,062,820	1.682	.149	1.831
Ohio	6,887,610		865,719	7,753,329	4,207,944	1.637	.206	1.843
Pennsylvania	6,659,375	331,677	892,689	7,883,741	4,244,566	1.647	.210	1.857
West Virginia	727,092		128,059	855,151	444,824	1.634	.288	1.922
Undistributed [1]	420,288		13,873	434,161	226,807	1.853	.061	1.914
	25,173,825	1,314,623	3,182,588	29,671,036	15,686,442	1.689	.203	1.892

[1] Includes Colorado, Iowa, and Utah.

Foreign iron and manganiferous iron ore consumed in the manufacture of pig iron in the United States, 1933–34, by sources of ore, in gross tons

Source of ore	1933	1934	Source of ore	1933	1934
Africa	89,973	57,413	Spain		32,888
Australia	51,399	54,653	Sweden	42,449	28,089
Brazil	2,333	351	U. S. S. R. (Russia)	183,766	140,327
Canada	260		Undistributed		232
Chile	522,351	866,469			
Cuba	160,439	134,191		1,052,970	1,314,623
India		10			

Stocks of ore at mines.—According to the reports of producers the total quantity of iron ore in stock at the mines at the end of 1934 totaled 10,340,690 gross tons, a decrease of 6 percent from 1933. These stocks were about 1,474,000 tons below the average for the 5-year period 1929–33.

Stocks of iron ore at mines, Dec. 31, 1933–34, by States, in gross tons

State	1933	1934	State	1933	1934
Alabama	775,999	398,895	New York	74,009	90,011
Georgia	1,000		North Carolina	200	200
Iowa	12,165	12,165	Pennsylvania	450	450
Michigan	6,675,360	6,658,952	Virginia	3,473	3,473
Minnesota	3,021,496	2,775,198	Wisconsin	258,562	278,164
Missouri	5,055	4,571			
New Jersey	125,252	118,611		10,953,021	10,340,690

Foreign trade in iron ore.—The iron ore imported into the United States totaled 1,427,521 gross tons valued at $3,307,504 in 1934, an increase of 66 percent in quantity and 61 percent in total value over 1933. Chile continued to be the chief source of imports, furnishing 66 percent of the total, while Cuba supplied 11 percent and U. S. S. R. (Russia) 7 percent.

Iron ore imported into the United States, 1932–34, by countries

Country	1932		1933		1934	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Africa:						
Algeria and Tunisia	10,000	$25,632	28,280	$101,296	49,850	$179,929
Morocco			15,510	63,181	6,100	25,900
Australia					49,689	89,568
Belgium	5,012	12,605				
Brazil			3,600	14,757		
Canada	807	2,584	90	316	11,126	56,486
Chile	218,492	517,725	467,650	940,753	938,376	1,914,069
Cuba	77,000	184,143	143,150	330,526	154,500	363,674
Germany	150	2,111	700	11,944	20	614
India, British			1,199	4,678		
Italy			9	50		
Mexico	281	622	148	310	1,618	3,584
Netherlands					169	3,374
Norway	99,911	399,943	62,334	247,202	68,249	240,738
Persia			1,500	25,549		
Spain	245	1,952	900	8,711	1,159	13,676
Sweden	7,037	27,938	2	10	40,535	202,079
United Kingdom	822	7,324	241	7,455	5,525	36,439
U. S. S. R. (Russia)	162,740	356,775	135,840	297,574	100,605	177,374
Venezuela	1	20				
	582,498	1,539,374	861,153	2,054,312	1,427,521	3,307,504

Exports of iron ore from the United States totaled 608,922 gross tons valued at $2,243,066 ($3.68 a ton) in 1934 compared with 155,271 tons valued at $646,533 ($4.16 a ton) in 1933. Of the iron ore exported in 1934, 608,697 tons went to Canada, 212 to Japan, and 13 to Mexico.

Iron-ore mining in Cuba.—Iron ore totaling 178,260 gross tons was shipped from Cuba to the United States in 1934, an increase of 7 percent over 1933. It comprised 72,559 tons of hematite carrying 56.33 percent iron (dried) and 94,324 tons of siliceous ore carrying 29.63 percent iron from the Daiquiri and Juragua mines on the southern coast, and 11,377 tons of nodulized brown ore carrying 55.22 percent iron from the Mayari mines near the northern coast.

The total stock of ore reported on hand was 565,864 gross tons at the end of 1934 compared with 651,250 tons at the end of 1933.

The following table shows the shipments of iron ore from Cuba since the mines were opened in 1884. The statistics of the shipments of Cuban iron ore are collected by the Bureau of Mines.

Iron ore shipped from mines in the Province of Oriente, Cuba, 1884–1934, in gross tons

Year	Juragua (hematite and magnetite) Daiquiri (hematite and a little magnetite)	Sigua (hematite)	Mayari (brown ore)	Guamá (hematite)	El Cuero (hematite)	Total
1884–1932	[1] 20,442,223	20,438	3,681,949	41,241	903,103	25,088,954
1933	166,813					166,813
1934	166,883		11,377			178,260
	20,775,919	20,438	3,693,326	41,241	903,103	25,434,027

[1] Of this quantity, 5,932 tons sent to Pictou, Nova Scotia, and 64,228 tons sent to ports outside of the United States.

REVIEW OF LAKE SUPERIOR DISTRICT

Production.—The total quantity of iron ore mined in the Lake Superior district was 21,030,756 gross tons in 1934, an increase of 44 percent compared with 1933. The output of the several ranges is shown in the following table. After 1905 the figures do not include manganiferous iron ore containing 5 percent or more manganese. The Mesabi range produced 69 percent of the iron-ore output of the Lake Superior district (78 percent in 1933) and 59 percent of the total output of the United States (65 percent in 1933). The proportion contributed by this range was remarkably uniform from 1915 to 1931; for the Lake Superior district the proportion from 1915 to 1931 ranged from 60 to 71 percent and averaged 66 percent, and for the United States it ranged from 50 to 60 percent and averaged 56 percent. In 1932 and 1933, however, the Mesabi range produced 52 and 78 percent, respectively, of the iron-ore output of the Lake Superior district and 43 and 65 percent, respectively, of the total output of the United States.

Iron ore mined in the Lake Superior district, 1854–1934, by ranges, in gross tons

[Exclusive after 1905 of ore containing 5 percent or more manganese]

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1932	178, 698, 388	175, 479, 690	191, 233, 985	60, 307, 552	909, 881, 864	23, 483, 629	1, 539, 085, 108
1933	991, 604	561, 508	1, 109, 324	301, 786	11, 366, 813	279, 997	14, 611, 032
1934	2, 330, 776	858, 056	2, 452, 054	782, 592	14, 415, 247	192, 031	21, 030, 756
	182, 020, 768	176, 899, 254	194, 795, 363	61, 391, 930	935, 663, 924	23, 955, 657	1, 574, 726, 896

The average daily wage in Michigan increased from $3.92 in 1933 to $4.51 in 1934, and in St. Louis County, Minn., it advanced from $4.41 in 1933 to $4.88 in 1934.

The operators' gross profit (exclusive of idle mine cost) at underground mines in Michigan, according to the State mine appraiser, was $0.49 a ton in 1934 ($0.79 gross loss in 1933).

Shipments.—The shipments of ore from the Lake Superior district amounted to 22,060,822 gross tons (21,862,262 tons of iron ore and 198,560 tons of manganiferous iron ore containing 5 percent or more manganese) in 1934 compared with 21,674,972 tons (21,496,805 tons of iron ore and 178,167 tons of manganiferous iron ore) in 1933. In addition, 2,202 tons of iron ore were shipped for paint in 1934 compared with 451 tons in 1933.

Iron-ore analyses.—The iron content of the iron ore and manganiferous iron ore shipped from the Lake Superior district in 1934 averaged 51.56 percent (natural) compared with 51.85 percent in 1933 and 52.16 percent in 1932, showing how closely these ores are graded.

The following table, compiled by the Lake Superior Iron Ore Association, summarizes the average analyses of the total tonnages of all grades of ore shipped and shows the remarkable uniformity maintained during the past 5 years. This uniformity does not, of course, mean that the average grade of the available Lake Superior ore is not declining. The grade of shipments has been maintained by methods of beneficiation and by mixing ores from different deposits.

Average analyses of total tonnages of all grades of iron ore from all ranges of Lake Superior district, 1930–34

Year	Gross tons	Iron (natural)	Phosphorus	Silica	Manganese	Moisture
		Percent	*Percent*	*Percent*	*Percent*	*Percent*
1930	46, 698, 554	51. 33	0. 095	8. 70	0. 82	10. 92
1931	23, 281, 333	51. 53	. 087	8. 60	. 80	10. 84
1932	3, 552, 575	52. 16	. 099	9. 05	. 68	9. 92
1933	21, 455, 174	51. 85	. 090	8. 96	. 71	10. 47
1934	21, 841, 382	51. 56	. 087	8. 93	. 76	10. 66

Stocks of ore at Lake Erie ports.—According to the Lake Superior Iron Ore Association, at the close of navigation in 1934, 5,248,555 gross tons of iron ore were in stock at Lake Erie ports compared with 5,405,691 tons on the corresponding date in 1933. At the opening of navigation in May 1935, 4,173,204 tons were in stock at these ports, indicating a withdrawal of 1,075,351 tons during the winter of 1934–35. The average quantity withdrawn each winter during the preceding 5 years was about 956,000 tons.

Prices of Lake Superior ore.—The unit prices established May 21–26, 1934, for the four standard grades of Lake Superior ore are the same as those for 1929–33, as follows: Old-range Bessemer, 9.32 cents; Mesabi Bessemer, 9.029 cents; old-range non-Bessemer, 9.029 cents; and Mesabi non-Bessemer, 8.738 cents. The prices per ton that correspond to these prices are, respectively, $4.80, $4.65, $4.65, and $4.50. The base of Bessemer ore, old-range and Mesabi, for 1925–34 is a metallic iron content of 51.5 percent (natural), instead of 55 percent, as for 1924 and many earlier years. The base of non-Bessemer ore, old-range and Mesabi, remains as heretofore at 51.6 percent (natural).

Iron-ore reserves.—Estimates of ore reserves for Minnesota, furnished by the Minnesota Tax Commission, and for Michigan, furnished by the Michigan Board of State Tax Commissioners, cover developed and prospective ore in the ground and ore in stock piles. These estimates show decreases from the previous year of 33,177,000 tons in Minnesota and of 1,808,000 tons in Michigan.

Iron-ore reserves in Minnesota, May 1, 1930–34, in gross tons

Range	1930	1931	1932	1933	1934
Mesabi	1, 154, 434, 031	1, 162, 776, 979	1, 190, 295, 183	1, 205, 213, 398	1, 195, 271, 786
Vermilion	14, 250, 540	14, 789, 137	14, 237, 637	14, 007, 192	13, 243, 125
Cuyuna	66, 542, 939	66, 756, 610	69, 699, 960	70, 024, 921	47, 553, 536
	1, 235, 227, 510	1, 244, 322, 726	1, 274, 232, 780	1, 289, 245, 511	1, 256, 068, 447

Iron-ore reserves in Michigan, Jan. 1, 1931–35, in gross tons

Range	1931	1932	1933	1934	1935
Gogebic	51, 143, 511	50, 793, 057	50, 473, 546	48, 612, 579	47, 721, 016
Marquette	57, 665, 510	56, 335, 788	55, 894, 039	54, 564, 005	53, 513, 561
Menominee (including Iron River and Crystal Falls districts)	62, 178, 324	59, 940, 058	58, 264, 532	60, 845, 357	60, 978, 904
	170, 987, 345	167, 068, 903	164, 632, 117	164, 021, 941	162, 213, 481

IRON-ORE MINING, BY STATES

Alabama.—The production of iron ore in Alabama in 1934 was 2,343,819 gross tons (2,065,915 tons of hematite and 277,904 tons of brown ore), an increase of 10 percent over 1933. The hematite, much of which contains enough lime to make it self-fluxing or nearly so, was produced at the Raimund Nos. 1 and 2, Red Mountain group, Sloss Nos. 1 and 2, Spaulding, and Woodward No. 3 mines, all underground operations in Jefferson County, and at an open-pit property near Tumlin Gap in Etowah County. The iron content of the hematite produced in 1934 averaged 36.13 percent (natural), the manganese content 0.16 percent, and the phosphorus content 0.31 percent. The Red Mountain group (1,177,419 tons) was the largest producing mine in Alabama and the third largest in the United States in 1934.

The brown ore mined in 1934 averaged 48.66 percent iron (natural) and 0.98 percent manganese; it was produced chiefly from the Champion mines in Blount County, the Russellville mines in Franklin County, and the Shelby mine in Shelby County.

California.—The production of iron ore in California amounted to 16,333 gross tons in 1934, of which 15,783 tons were hematite mined in San Bernardino County and used in the manufacture of cement and 550 tons were magnetite concentrates recovered from black sand extracted from the beach at Rob Roy, Santa Cruz County, and used in making a heavy aggregate for counterweights for a bridge.

Georgia.—Brown ore amounting to 164 gross tons was produced in Georgia from the Grady mine in Polk County and from a property in Bartow County.

Michigan.—Mining activity on the Michigan ranges in 1934 was on a substantially increased scale, as is shown by a production of 5,039,144 gross tons compared with 2,433,949 tons in 1933. The iron content (natural) of the ore mined in 1934 averaged 51.84 percent compared with 51.55 percent in 1933. Of the 35 mines active in Michigan in 1934 (37 in 1933), 22 (8 in 1933) yielded more than 100,000 tons each. The Newport mine in Gogebic County had the largest output of any mine in Michigan in 1934—339,390 tons. The average production per mine in Michigan was 143,976 tons in 1934 compared with 65,782 tons in 1933.

The ore reserves in Michigan on January 1, 1935 were 162,213,481 gross tons, a decrease of 1,808,460 tons from the previous year.

A report on the iron-ore mines of Michigan for 1934, published by the geological survey division of the Michigan Department of Conservation,[2] shows that the average number of men employed per day was 4,380 (2,739 in 1933), the average number of days worked 215 (93 in 1933), the average daily wage $4.51 ($3.92 in 1933), the average yearly earning $969.35 ($364.95 in 1933), and the average tons of ore mined per man per day 5.44 (4.15 in 1933).

The data in the following table on average per-ton costs of mining ore at underground mines have been abstracted from statistics published in much greater detail by the geological survey division.

[2] Pardee, F. G., and Osgood, W., General Statistics Covering Costs and Production of Michigan Iron Mines: Michigan Dept. of Conservation, Geol. Survey Div., Lansing, 1935.

Average per-ton costs of mining iron ore at underground mines and at siliceous open pits in Michigan in 1934

Item	Underground				Siliceous open pits
	Gogebic	Marquette	Dickinson and Iron	Total	
Cost of mining	$1.6596	$1.4722	$1.6483	$1.5760	$0.3382
Deferred mining cost	.2145	.0681	.1640	.1413	.0481
Taxes	.4708	.2673	.2226	.3353	.0352
General overhead	.2532	.3038	.3067	.2852	.1196
Transportation	1.6213	1.4301	1.4775	1.5160	1.4058
Marketing	.0350	.0862	.0714	.0653	.0937
Royalty	.3655	.2359	.2602	.2859	.1020
Interest on borrowed money	.0229	.0145	.0575	.0258	.0014
Total ore cost	4.6428	3.8781	4.2082	4.2308	2.1440
Lake Erie value per ton	4.8853	4.7606	4.3292	4.7248	2.2394
Gross ore profit [1]	.2425	.8825	.1210	.4940	.0954

[1] This figure does not represent true profit, as much ore is sold below the Lake Erie price.

Minnesota.—Mining and shipping of iron ore in Minnesota were stimulated somewhat in 1934. The production increased from 11,948,596 tons in 1933 to 15,389,870 tons in 1934, and shipments advanced from 14,784,763 tons in 1933 to 15,768,418 tons in 1934. Mining at underground mines doubled—from 1,542,887 tons in 1933 to 3,081,761 tons in 1934. Production at open-pit mines increased only 18 percent and thus supplied only 80 percent of the total iron ore mined in Minnesota in 1934 compared with 87 percent in 1933. The proportion produced from open-pit mines in Minnesota during the 4-year period 1930–33 averaged 74 percent. The iron content (natural) of the ore mined in 1934 averaged 51.63 percent compared with 51.84 percent in 1933. Of the 57 active mines in Minnesota in 1934 (58 in 1933), 35 (32 in 1933) yielded more than 100,000 tons each. The Hartley-Burt mine, an open-pit operation in St. Louis County which yielded 2,000,942 tons, was the largest producing mine in the United States in 1934. The Sellers mine, also an open-pit operation, and the Adams-Spruce group, a combination open-pit and underground operation, both in St. Louis County, yielded over a million tons each in 1934. The average production per mine in Minnesota was 269,998 tons in 1934 compared with 206,010 tons in 1933.

The reserves of ore in Minnesota on May 1, 1934, were 1,256,068,447 gross tons, a decrease of 33,177,064 tons from the previous year.

According to the annual report of the mine inspector of St. Louis County an average of 4,272 men was employed in iron-ore mines in St. Louis County during 1934 (2,843 in 1933), and the average daily wage was $4.88 ($4.41 in 1933). In 1934, 2,395,869 cubic yards of stripping were removed compared with 1,283,760 cubic yards in 1933.

According to the annual report of the mine inspector of Itasca County an average of 1,921 men was employed at iron-ore mines in Itasca County in 1934 and the average daily wage was $4.74. In 1934, 2,044,720 cubic yards of overburden were removed compared with 1,366,042 cubic yards in 1933.

The data in the following table on costs of developing and mining iron ore have been abstracted from statistics published in greater detail by the Minnesota Tax Commission.

Average per-ton costs of developing and mining iron ore at open-pit and underground operations in Minnesota, 1929–33

Year	Developing	Mining			Royalty	Total
		Labor	Supplies	Other items		
Open-pit operations:						
1929	$0.260	$0.112	$0.124	$0.113	$0.456	$1.065
1930	.270	.113	.122	.154	.459	1.118
1931	.254	.111	.121	.221	.428	1.135
1932	.392	.087	.118	.401	.647	1.645
1933	.259	.098	.116	.226	.419	1.118
Underground or mixed operations:						
1929	.055	.862	.416	.189	.447	1.969
1930	.056	.852	.429	.201	.452	1.990
1931	.051	.747	.410	.303	.460	1.971
1932	.051	.722	.502	.511	.418	2.204
1933	.138	.700	.466	.352	.421	2.077

Missouri.—The production of iron ore in Missouri increased from 395 gross tons in 1933 to 4,104 tons in 1934. The output in 1934 consisted of 3,704 tons of brown ore from Bollinger, Howell, and Madison Counties and 400 tons of hematite from Dent County. Shipments from Missouri in 1934 were 4,154 tons, of which 3,704 tons were for use in making cement and 450 tons for use in open-hearth steel plants.

New Jersey.—The only active mines in New Jersey in 1934 were the Washington and Scrub Oaks mines, underground operations in Warren and Morris Counties, respectively; they yielded 138,685 gross tons of magnetite concentrates averaging 58.33 percent iron. The production of New Jersey in 1933 was 73,144 tons. Magnetite concentrates amounting to 6,641 tons (some of which was used in making cement) and averaging 61.35 percent iron were shipped from the stock pile at the Mt. Hope mine in Morris County in 1934.

New York.—The production of iron ore in New York increased from 58,718 gross tons in 1933 to 244,962 tons in 1934. The output in 1934 was chiefly magnetite from the Harmony and Old Bed mines in Essex County and the Chateaugay mine in Clinton County. Some Clinton iron ore for use in making paint was mined in Oneida and Wayne Counties in 1934. Shipments from New York in 1934 consisted of 197,056 tons of sinter averaging 67.86 percent iron, 28,339 tons of concentrates averaging 68.4 percent iron, and 9,630 tons of lump ore averaging 62.5 percent iron.

Pennsylvania.—Pennsylvania, the most important source of magnetite in the United States, produced 525,297 gross tons of ore in 1934 compared with 264,366 tons in 1933. The production consisted chiefly of 523,793 tons of magnetite from the Cornwall mines in Lebanon County; it averaged 40.49 percent iron (natural). Some hydrated iron ore for use in gas purification was mined in Clearfield County, and some carbonate ore for use in paint was mined in Carbon County in 1934.

Tennessee.—The production of iron ore in Tennessee decreased from 24,912 gross tons in 1933 to 3,345 tons in 1934. The output in 1934 comprised 3,040 tons of brown-ore concentrates from the Van Leer mine in Lawrence County and 305 tons of hematite for use in paint from a property in Franklin County.

A considerable quantity of iron sinter recovered from copper sulphide ore mined in Polk County was shipped in 1934; this sinter averaged 66.11 percent iron, 0.16 percent manganese, and 0.006 percent phosphorus. These shipments are not included in the statistics of iron ore.

Utah.—The production of iron ore in Utah in 1934 was 161,109 gross tons compared with 95,279 tons in 1933. It was chiefly hematite, averaging 52.3 percent iron (natural), from the Desert Mound mine in Iron County. A small quantity of iron ore for use in paint was produced at the Tecoma mine in Box Elder County.

Virginia.—The production of iron ore in Virginia in 1934 was limited to 297 gross tons of hand-picked brown ore from the Oriskany mine in Botetourt County; the ore was for use in hydrogen gas.

Washington.—The Big Iron mine in Stevens County was the only active mine in Washington in 1934. It produced 1,920 gross tons of magnetite, which was shipped for use in making ferromagnesite.

Wisconsin.—The production of iron ore in Wisconsin increased from 228,487 gross tons in 1933 to 602,005 tons in 1934. The Montreal mine (579,965 tons) in Iron County was the chief producing mine. The Cary mine, also in Iron County, produced 21,777 tons in 1934. A small quantity of ore for use in paint was mined at the Iron Ridge mine in Dodge County in 1934.

Wyoming.—The production of iron ore in Wyoming in 1934 was 116,562 gross tons, a decrease of 60 percent from 1933. The output was from the Sunrise mine in Platte County. The ore is hematite; that produced in 1934 averaged 55.2 percent iron (natural), 0.08 percent manganese, and 0.07 percent phosphorus.

WORLD PRODUCTION

The following table shows the production of iron ore by countries from 1930 to 1934, so far as figures are obtainable. Figures for preceding years appear in earlier volumes of Mineral Resources. Complete returns for 1934 are not yet available, but those for 1933 and earlier years are fairly complete. Thus, the figures for 1933 indicate a total world production of about 91,000,000 metric tons, of which the United States furnished about 20 percent. In 1932 the United States contributed about 13 percent of the world total, which was about 75,414,000 metric tons.

Iron ore produced, 1930–34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1930	1931	1932	1933	1934
North America:					
Cuba [1]	190,270	92,407	82,610	169,490	181,121
Mexico	106,979	65,156	27,122	77,714	(2)
Newfoundland [3]	1,196,856	716,579	150,867	240,934	661,477
United States	59,346,123	31,631,163	10,004,959	17,834,917	24,982,247
South America:					
Brazil [4]	30,000	30,000	30,000	30,000	30,000
Chile [5]	1,695,089	741,650	172,681	559,598	969,285
Europe:					
Austria	1,180,451	511,945	306,796	267,032	(2)
Belgium	130,990	125,820	92,810	102,700	(2)
Czechoslovakia	1,652,920	1,235,078	602,215	428,772	(2)
France	48,570,980	38,558,650	27,554,000	30,400,000	32,000,000
Germany [6]	5,658,574	2,574,049	1,319,142	2,534,768	(2)
Greece	256,161	235,967	46,022	(2)	(2)
Hungary	157,421	84,033	52,864	50,021	(2)
Italy	718,124	560,853	412,326	507,995	(2)
Luxemburg	6,649,372	4,764,926	3,212,618	3,362,417	3,828,308
Norway	772,423	574,887	373,907	473,863	(2)
Poland	476,846	284,653	76,869	160,661	247,365
Portugal	(7)	(7)	----------	4,500	(2)
Rumania	92,517	61,907	8,051	13,831	(2)
Spain	5,517,211	3,190,203	1,760,471	1,815,484	(2)
Sweden	11,236,428	7,070,868	3,298,989	2,698,750	(2)
Switzerland [8]	101,925	34,239	11,862	7,089	(2)
United Kingdom: Great Britain [9]	11,813,850	7,748,255	7,445,807	7,581,481	(2)
U. S. S. R. (Russia) [10]	10,425,000	10,612,000	12,200,000	14,500,000	21,700,000
Yugoslavia	431,189	133,411	26,635	52,465	(2)
Asia:					
China [11]	2,261,200	2,202,875	1,605,422	2,114,466	(2)
Chosen	532,497	164,712	390,937	258,267	(2)
India, British	1,879,311	1,650,962	1,788,757	1,248,344	(2)
Indo China	----------	----------	----------	420	(2)
Japan	245,992	208,182	226,722	(2)	(2)
Unfederated Malay States	790,268	703,092	699,224	778,774	(2)
U. S. S. R. (Russia)	(10)	(10)	(10)	(10)	(10)
Africa:					
Algeria	2,231,868	900,850	466,936	761,454	1,326,400
Belgian Congo	14,000	19,000	14,614	(2)	(2)
Egypt	----------	----------	25	----------	----------
Morocco, Spanish [8]	752,715	500,650	171,182	515,838	824,812
Rhodesia:					
Northern	10	771	722	----------	(2)
Southern	2,524	535	----------	----------	(2)
Sierra Leone	----------	----------	----------	24,944	(2)
South-West Africa	39,969	22,214	(2)	(2)	(2)
Tunisia	828,000	446,600	209,000	285,000	546,500
Union of South Africa [1]	51,662	15,447	16,024	60,060	228,913
Oceania:					
Australia:					
New South Wales	----------	----------	----------	2,471	(2)
Queensland	2,456	4,629	8,364	8,690	(2)
South Australia	943,293	293,820	546,562	732,760	(2)
New Zealand [12]	16,409	7,031	----------	6,588	(2)
	179,000,000	118,780,000	75,414,000	91,000,000	(2)

1 Shipments.
2 Data not available.
3 Shipments from Wabana mines.
4 Approximate production.
5 Production of Tofo mines.
6 Exclusive of manganiferous iron ore carrying 12 to 30 percent manganese.
7 Less than 1 ton.
8 Exports.
9 Exclusive of bog ore, which is used mainly for the purification of gas.
10 Russia in Asia included with Russia in Europe.
11 Including Manchuria.
12 Quantity smelted; production not available.

PIG IRON

Production and shipments.—The total production of pig iron, exclusive of ferro-alloys, reported by manufacturers to the Bureau of Mines, was 15,686,442 gross tons in 1934 compared with 13,027,343 tons in 1933. The production in 1934 consisted of 15,660,622 tons made with coke as fuel and 25,820 tons made with charcoal. Pennsylvania, second to Ohio in both 1932 and 1933 in the production of pig iron, regained first place in 1934. Of the pig iron manufactured in 1934 it is calculated that 794,458 gross tons valued at $14,000,650 were made from 1,314,623 gross tons of foreign ore from Africa, Australia, Brazil, Chile, Cuba, India, Spain, Sweden, and U. S. S. R. (Russia), indicating an average pig-iron yield of 60.43 percent from imported ore. Domestic ore (25,173,825 tons) and 3,182,588 gross tons of cinder, scale, and scrap, amounting in all to 28,356,413 tons, were reported as used in making 14,891,984 tons of pig iron, indicating an average pig-iron yield of 52.52 percent from domestic materials.

Pig iron manufactured in the United States, 1933–34, by States, in gross tons

State	1933	1934	State	1933	1934
Alabama	900, 170	1, 171, 650	New York	665, 933	1, 062, 820
Illinois	1, 012, 676	1, 269, 154	Ohio	3, 918, 723	4, 207, 944
Indiana	1, 183, 405	1, 563, 350	Pennsylvania	3, 733, 570	4, 244, 566
Kentucky	103, 017	169, 290	West Virginia	410, 421	444, 824
Maryland	617, 187	704, 850	Undistributed [1]	173, 926	226, 807
Michigan	308, 315	621, 187			
				13, 027, 343	15, 686, 442

[1] 1933: Colorado, Iowa, Tennessee, and Utah; 1934: Colorado, Iowa, and Utah.

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for 1933 and 1934, exclusive of electric-reduction furnaces, were as follows:

Blast furnaces (including ferro-alloy blast furnaces) in the United States, 1933–34 [1]

State	In blast June 30, 1933	Dec. 31, 1933			In blast June 30, 1934	Dec. 31, 1934		
		In	Out	Total		In	Out	Total
Alabama	7	10	15	25	10	6	16	22
Colorado		1	2	3	1		3	3
Illinois	7	4	21	25	6	5	20	25
Indiana	7	5	13	18	6	5	13	18
Kentucky	1	1	1	2	2	1	1	2
Maryland	3	3	3	6	3	3	3	6
Massachusetts			1	1			1	1
Michigan	3	4	4	8	6	5	3	8
Minnesota			3	3			3	3
Missouri			1	1			1	1
New York	4	7	12	19	7	4	15	19
Ohio	24	19	36	55	26	19	36	55
Pennsylvania	29	19	74	93	26	17	73	90
Tennessee	2		6	6	1		5	5
Utah	1	1		1	1	1		1
Virginia			6	6			6	6
West Virginia	3	1	2	3	3	2	1	3
	91	75	200	275	98	68	200	268

[1] American Iron and Steel Institute.

The total shipments of pig iron, exclusive of ferro-alloys, reported by manufacturers to the Bureau of Mines, were 15,632,619 gross tons valued at $264,653,746 in 1934, an increase of 9 percent in quantity and 24 percent in total value over 1933. Compared with the 5-year average for 1927–31, which amounted to 32,487,488 tons, the 1934 shipments decreased 52 percent. The values given represent the approximate amounts received for the iron f. o. b. furnaces and do not include freight costs, selling commissions, and other items that are figured in some of the market prices of pig iron published in trade journals.

Pig iron shipped from blast furnaces in the United States, 1933–34, by States

State	1933		1934	
	Gross tons	Value	Gross tons	Value
Alabama	987,606	$11,385,080	1,144,900	$15,805,365
Colorado	(1)	(1)	(1)	(1)
Illinois	1,269,940	20,063,481	1,430,841	25,768,115
Indiana	1,296,518	19,989,998	1,545,011	27,977,992
Iowa	(1)	(1)	(1)	(1)
Kentucky	103,017	(1)	170,399	(1)
Maryland	639,539	(1)	704,304	(1)
Massachusetts	(1)	(1)	(1)	(1)
Michigan	407,011	6,181,318	644,895	9,987,451
Minnesota	(1)	(1)	(1)	(1)
New York	851,496	12,344,827	961,679	14,621,274
Ohio	4,188,482	60,995,721	4,147,116	68,525,145
Pennsylvania	3,952,862	62,797,008	4,173,412	76,740,066
Tennessee	14,656	(1)	10,760	(1)
Utah	(1)	(1)	(1)	(1)
Virginia	3,092	(1)	3,843	(1)
West Virginia	449,219	(1)	445,688	(1)
Undistributed	[2] 189,759	[2] 19,590,150	[2] 249,771	[2] 25,228,338
	14,353,197	213,347,583	15,632,619	264,653,746

[1] Included under "Undistributed." [2] Includes figures for States entered as "(1)" above.

Pig iron shipped from blast furnaces in the United States, 1933–34, by grades

Grade	1933			1934		
	Gross tons	Value		Gross tons	Value	
		Total	Average		Total	Average
Charcoal	53,678	$1,038,716	$19.35	56,753	$1,128,479	$19.88
Foundry	1,448,584	19,684,877	13.59	1,326,861	21,278,038	16.04
Basic	8,788,335	126,990,109	14.45	10,204,967	168,383,542	16.50
Bessemer	3,180,506	51,915,711	16.32	3,045,365	55,478,331	18.22
Low-phosphorus	121,076	2,487,060	20.54	148,817	3,133,095	21.05
Malleable	732,453	10,668,083	14.56	805,686	14,324,481	17.78
Forge	6,985	75,493	10.81	14,587	255,168	17.49
All other (not ferro-alloys)	21,580	487,534	22.59	29,583	672,612	22.74
	14,353,197	213,347,583	14.86	15,632,619	264,653,746	16.93

Value at blast furnaces.—The average value of all kinds of pig iron given in the accompanying table is based on the reports of the manufacturers to the Bureau of Mines. The figures represent the approximate values f. o. b. blast furnaces and do not include the values of ferro-alloys. The general average value for all grades of pig iron at the furnaces was $16.93 a gross ton in 1934—$2.07 more than in 1933 but 53 cents less than the average for 1927–31.

Average value per gross ton of pig iron at blast furnaces in the United States, 1930–34

State	1930	1931	1932	1933	1934
Alabama	$13.55	$12.38	$11.01	$11.53	$13.81
Illinois	17.80	16.89	15.77	15.80	18.01
Indiana	16.54	16.53	15.45	15.42	18.11
Michigan	18.08	17.25	15.22	15.19	15.49
New York	17.80	15.35	14.38	14.50	15.20
Ohio	17.05	16.08	15.12	14.56	16.52
Pennsylvania	18.13	17.04	15.83	15.89	18.39
Tennessee	19.64	22.39	(1)	(1)	(1)
Other States [2]	15.85	14.81	13.40	14.00	15.92
Average for United States	17.13	16.01	14.80	14.86	16.93

[1] Included under "Other States."
[2] 1930: Colorado, Kentucky, Maryland, Massachusetts, Minnesota, New Jersey, Utah, Virginia, and West Virginia; 1931: Colorado, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Utah, Virginia, and West Virginia; 1932–34: Colorado, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Tennessee, Utah, Virginia, and West Virginia.

Commercial quotations.—The average monthly prices, according to published market quotations of foundry, basic, and Bessemer pig iron at Valley furnaces and of foundry pig iron at Birmingham furnaces, are summarized in the following table.

Average monthly prices per ton of chief grades of pig iron, 1933–34 [1]

Month	Foundry pig iron at Valley furnaces		Foundry pig iron at Birmingham furnaces		Bessemer pig iron at Valley furnaces		Basic pig iron at Valley furnaces	
	1933	1934	1933	1934	1933	1934	1933	1934
January	$14.50	$17.50	$11.00	$13.50	$15.00	$18.00	$14.00	$17.00
February	14.50	17.50	11.00	13.50	15.00	18.00	14.00	17.00
March	14.50	17.50	11.00	13.50	15.00	18.00	14.00	17.00
April	14.50	17.90	11.44	14.02	15.00	18.40	14.00	17.40
May	15.04	18.50	12.00	14.50	15.54	19.00	14.54	18.00
June	15.50	18.50	12.00	14.50	16.00	19.00	15.00	18.00
July	16.18	18.50	12.68	14.50	16.68	19.00	15.68	18.00
August	16.57	18.50	13.07	14.50	17.07	19.00	16.07	18.00
September	17.50	18.50	13.50	14.50	18.00	19.00	17.00	18.00
October	17.50	18.50	13.50	14.50	18.00	19.00	17.00	18.00
November	17.50	18.50	13.50	14.50	18.00	19.00	17.00	18.00
December	17.50	18.50	13.50	14.50	18.00	19.00	17.00	18.00
Average	15.94	18.20	12.35	14.71	16.44	18.70	15.44	17.70

[1] Metal statistics, 1935.

Foreign trade in pig iron.—The pig iron imported for consumption in the United States in 1934 was 114,488 gross tons, compared with 134,456 tons imported for consumption in 1933. Netherlands (65,439 tons) and India (36,013 tons) were the chief sources of supply in 1934.

Pig iron imported into the United States, 1930–34, by countries, in gross tons [1]

Country	1930	1931	1932	1933	1934 [1]
North America:					
Canada	664	2,789	2,113	12,259	8,984
Mexico	41				
South America: Chile					89
Europe:					
Belgium	669	300	200	225	100
France		25	97		
Germany	50	202	361	200	100
Netherlands	6,243	7,209	74,372	68,341	65,439
Norway	2,610	227	140	806	1,203
Sweden	4,092	1,900	561	632	991
United Kingdom	14,239	2,656	23,378	5,495	600
Asia:					
Hong Kong		2			
India, British	108,261	67,930	28,820	68,036	36,013
Japan	102	20	279	208	
Kwantung	60	1,098	309	2,394	969
Oceania: Australia		53			
	137,031	84,411	130,630	158,596	114,488
Value	$1,806,754	$978,683	$1,301,625	$1,439,206	$1,465,475

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

Exports of pig iron from the United States in 1934 were 4,096 gross tons compared with 2,750 tons in 1933. Japan (1,037 tons) and Canada (907 tons) were the chief customers in 1934.

Pig iron exported from the United States, 1933–34, by countries, in gross tons

Country	1933	1934	Country	1933	1934
North America:			Europe—Continued.		
Canada	310	907	Italy	22	64
Cuba	40	46	Poland and Danzig	100	50
Mexico	498	478	United Kingdom	10	41
Panama	9	295	Other countries		25
Other countries	18	101			
South America:			Asia:		
Chile	100		China		109
Colombia	172	304	Japan	258	1,037
Peru	259	2	Philippine Islands	427	254
Other countries	140	9			
Europe:				2,750	4,096
Belgium	312	374	Value	$63,985	$97,050
Germany	75				

World production of pig iron.—World production of pig iron (including ferro-alloys) in 1934 was approximately 61,049,000 metric tons, an increase of 24 percent over 1933 but 26 percent below the average for 1927–31. In 1934 the output of the United States represented about 27 percent (28 percent in 1933) of the world output, and it was about 59 percent (57 percent in 1933) less than that of the producing countries of Europe combined. The production of pig iron increased 27 percent in Europe in 1934 compared with an increase of 21 percent in the United States.

Pig iron (including ferro-alloys) produced, 1930–34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
Australia	[2] 447,000	[2] 386,000	[2] 400,000	[2] 425,000	[2] 450,000
Austria	296,824	145,016	94,466	87,949	133,567
Belgium	3,365,240	3,197,790	2,748,740	2,710,430	2,307,289
Brazil	34,974	[2] 35,000	[2] 35,000	[2] 35,000	[2] 35,000
Canada	825,440	474,294	162,179	263,813	447,143
China	[2] 300,000	[2] 300,000	[2] 300,000	[2] 300,000	[2] 300,000
Chosen	151,378	147,855	163,653	163,937	[2] 160,000
Czechoslovakia	1,437,089	1,164,726	450,106	498,980	[2] 500,000
Finland	10,379	12,329	13,671	12,004	[2] 15,000
France	10,071,980	8,206,130	5,550,000	6,359,000	6,155,000
Germany (exclusive of the Saar)	9,698,421	6,061,068	3,932,364	5,265,000	8,741,661
Saar	1,912,444	1,515,429	1,349,493	1,591,200	1,825,665
Great Britain	6,296,259	3,833,150	3,630,347	4,189,784	6,074,455
Hungary	257,226	159,630	66,281	93,072	[2] 100,000
India, British	1,198,802	1,089,919	928,345	1,082,664	[2] 1,100,000
Italy	587,594	552,852	494,667	566,895	[2] 600,000
Japan	1,338,023	934,191	1,036,680	1,463,000	1,720,000
Luxemburg	2,473,714	2,053,158	1,958,930	1,887,538	1,955,258
Mexico	57,826	52,926	[2] 60,000	53,500	[2] 60,000
Netherlands	272,718	256,717	236,426	252,645	[2] 250,000
New Zealand	8,205	3,516	[2] 4,000	3,339	[2] 4,000
Norway	144,836	118,837	103,092	112,653	[2] 120,000
Philippine Islands	173	163	168	100	[2] 150
Poland	477,949	347,114	198,674	305,625	382,000
Rumania	68,843	25,894	8,752	2,013	[2] 2,000
Spain	621,891	479,215	302,617	338,853	348,000
Sweden	496,410	417,506	282,163	345,526	[2] 400,000
Union of South Africa	29,726	8,940	13,107	26,492	[2] 30,000
United States	32,279,283	18,715,216	8,920,878	13,590,926	16,398,077
U. S. S. R. (Russia)	[3] 4,982,200	5,007,000	6,173,000	7,133,000	10,400,000
Yugoslavia	35,011	37,733	9,973	30,756	[2] 35,000
	80,178,000	55,739,000	39,628,000	49,191,000	61,049,000

[1] In addition to countries listed, pig iron is produced in Chile, but figures of production are not available.
[2] Approximate production.
[3] Year ended Sept. 30.

FERRO-ALLOYS

Production and shipments.—The production of ferro-alloys was 452,607 gross tons in 1934, compared with 348,894 tons in 1933, an increase of 30 percent. Ferro-alloys were made in 1934 at 11 blast furnaces, 14 electric furnaces, and 2 alumino-thermic plants; in addition, 2 plants made ferrophosphorus, and 2 plants made ferrosilicon as a byproduct.

The shipments of ferro-alloys of all classes in 1934 were 428,798 gross tons, valued at $34,634,957, an increase of 1.8 percent in quantity and 21 percent in total value compared with 1933. Compared with the 5-year average for 1927–31, which amounted to 663,861 tons, the 1934 shipments decreased 35 percent.

Ferro-alloys shipped from furnaces in the United States, 1933–34, by varieties

Variety of alloy	1933		1934	
	Gross tons	Value	Gross tons	Value
Ferromanganese	127,453	$9,384,611	147,947	$12,345,697
Spiegeleisen	50,218	1,144,642	45,769	1,099,922
Ferrosilicon (7 percent or more silicon)	199,524	7,349,681	181,209	7,401,799
Ferrotungsten	952	1,550,854	1,188	2,459,432
Ferrovanadium	890	1,961,644	864	(1)
Other varieties [2]	42,386	7,262,362	51,821	[1] 11,328,107
	421,423	28,653,794	428,798	34,634,957

[1] Value of ferrovanadium included with "Other varieties" in 1934.
[2] Ferrochromium, ferromolybdenum and calcium-molybdenum compounds, ferrophosphorus, ferrotitanium, ferrozirconium, silicomanganese and silicospiegeleisen, and zirconium-ferrosilicon.

Ferromanganese.—The shipments of ferromanganese in 1934 were 147,947 gross tons, an increase of 16 percent over 1933. Compared with the 5-year average for 1927–31, which amounted to 273,630 tons, the 1934 shipments decreased 46 percent. The average value per ton f. o. b. furnaces reported for ferromanganese was $83.45 in 1934 compared with $73.63 in 1933.

Ferromanganese was made at 6 furnaces in 1934 and at 5 furnaces in 1933.

The production of ferromanganese in 1934 was 139,171 gross tons containing 109,491 tons of manganese, an average of 78.67 percent manganese. In the production of ferromanganese in 1934, 256,980 gross tons of foreign manganese ore, 853 tons of domestic manganese ore, 13,933 tons of iron ore, and 3,304 tons of cinder, scale, and scrap were used. In 1934, 1.853 tons of manganese ore were used per ton of ferromanganese made; in 1933, 1.793 tons, and in 1932, 1.798 tons. Of the foreign manganese ore used in 1934, U. S. S. R. (Russia) supplied 116,953 gross tons; Brazil, 55,778 tons; India, 21,460 tons; Africa, 18,076 tons; Cuba, 16,242 tons; Chile, 451 tons; and undistributed, 28,020 tons. The quantity of domestic manganese ore used in the manufacture of ferromanganese in 1934 represented 0.33 percent of the total manganese ore used compared with 4.4 percent in 1933. The domestic manganese ore used in 1934 was produced in Georgia.

Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1930–34

Year	Ferromanganese produced			Materials consumed (gross tons)				Manganese ore used per ton of ferromanganese made (gross tons)
	Gross tons	Manganese contained		Manganese ore		Iron and manganiferous iron ores	Cinder, scale, and scrap	
		Percent	Gross tons	Foreign	Domestic			
1930	274,830	78.59	216,000	459,478	32,969	51,039	9,712	1.792
1931	166,937	78.59	131,200	287,973	12,277	19,214	3,405	1.799
1932	56,350	77.66	43,760	90,677	10,666	5,270	1,499	1.798
1933	136,267	79.30	108,059	233,607	10,695	10,795	1,655	1.793
1934	139,171	78.67	109,491	256,980	853	13,933	3,304	1.853

Quantity and tenor of manganese ore used in manufacture of ferromanganese in the United States, 1933–34

Source of ores	1933		1934	
	Gross tons	Manganese content (percent, natural)	Gross tons	Manganese content (percent, natural)
Africa	30,427	49.12	18,076	49.69
Brazil	42,805	43.62	55,778	43.86
Chile	1,046	44.28	451	44.28
Cuba	28,275	50.61	16,242	51.64
India	22,499	51.12	21,460	50.94
U. S. S. R. (Russia)	108,555	49.49	116,953	48.54
United States	10,695	44.39	853	37.00
Undistributed			28,020	50.32
	244,302	48.45	257,833	48.15

Spiegeleisen.—The shipments of spiegeleisen in 1934 were 45,769 gross tons (9 percent less than in 1933). Compared with the 5-year average for 1927–31 (94,239 tons) the 1934 shipments decreased 51 percent. The average value per ton at the furnaces was $24.03 in 1934 and $22.79 in 1933.

Ferrosilicon.—The shipments of ferrosilicon were 181,209 gross tons containing 40,659 tons of silicon in 1934 compared with 199,524 tons containing 42,765 tons of silicon in 1933. Compared with the 5-year average for 1927–31 (248,203 tons) the 1934 shipments showed a decrease of 27 percent.

The production of ferrosilicon in 1934 was 208,531 gross tons, including 141,279 tons made by the blast-furnace process, 67,010 tons by the electric-furnace process, and 242 tons as a byproduct of the manufacture of artificial abrasives in electric furnaces.

Ferrotungsten.—The shipments of ferrotungsten in 1934 were 1,188 gross tons containing 2,128,260 pounds of tungsten, and the average value per pound of contained tungsten was $1.16 f. o. b. furnaces (91 cents in 1933). Compared with the 5-year average for 1927–31 (1,584 tons) the 1934 shipments decreased 25 percent.

The production of ferrotungsten in 1934 was 1,146 gross tons averaging 80 percent tungsten. The ferrotungsten produced in 1934 was made from ores chiefly from China, Bolivia, Colorado, and Nevada.

Ferrovanadium.—The shipments of ferrovanadium in 1934 were 864 gross tons containing 771,600 pounds of vanadium. Compared with the 5-year average for 1927–31 (1,315 tons) the 1934 shipments decreased 34 percent.

The production of ferrovanadium in 1934 was 944 gross tons averaging about 40 percent vanadium. It was reduced from vanadium oxide made from roscoelite-carnotite ore mined in Colorado and from patronite and its oxidation products from Peru.

Foreign trade in ferro-alloys.—Imports of all alloys of the rarer metals are not recorded separately but are grouped as shown in the following table. Ferromanganese and spiegeleisen constituted the bulk of the imports in 1933 and 1934.

The imports for consumption of ferromanganese in 1934 (chiefly from Canada and Norway) were 23,349 gross tons, a decrease of 41 percent from 1933.

The imports for consumption of spiegeleisen in 1934 (chiefly from Canada) were 21,184 gross tons, a decrease of 19 percent from 1933.

Ferro-alloys and ferro-alloy metals imported for consumption in the United States, 1933–34, by varieties

Variety of alloy	1933			1934		
	Gross weight (gross tons)	Content (gross tons)	Value	Gross weight (gross tons)	Content (gross tons)	Value
Ferromanganese:						
Containing over 1 percent carbon	39,521	31,616	$2,521,349	23,088	18,483	$1,401,123
Containing not over 1 percent carbon	172	143	26,719	261	219	40,237
Manganese silicon (manganese content)	(1)	136	9,725	(1)	17	5,813
Manganese boron, manganese metal, and spiegeleisen not more than 1 percent carbon (manganese content)	(1)	24	11,773	(1)	2	1,327
Spiegeleisen	26,277	(1)	640,613	21,184	(1)	595,017
Ferrochrome or ferrochromium containing less than 3 percent carbon	168	110	34,353	110	72	15,242
Ferrophosphorus	55	(1)	1,994	33	(1)	1,901
Ferrosilicon:						
Containing 8 percent and less than 60 percent silicon	5,290	927	145,892	6,537	984	189,954
Chrome or chromium metal	43	(1)	49,316	16	(1)	21,617
Chromium and zirconium silicon and calcium silicide	258	(1)	41,471	534	(1)	72,965
Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum (molybdenum content)	(1)	(2)	158	(1)	(3)	86
Ferrotitanium	3	(1)	1,292	1	(1)	434
Tungsten and combinations, in lumps, grains, or powder:						
Tungsten metal (tungsten content)	(1)	30	28,466	(1)	48	69,879
Tungsten acid and other compounds of tungsten, n. s. p. f. (tungsten content)	(1)	(4)	1,401	(1)	(5)	2,306

[1] Not recorded. [2] 40 pounds. [3] 15 pounds. [4] 779 pounds. [5] 705 pounds.

Ferromanganese and ferrosilicon imported into the United States, 1933–34, by countries [1]

Country	Ferromanganese (manganese content) [2]				Ferrosilicon (silicon content) [3]			
	1933 [2]		1934 [1]		1933 [3]		1934 [1]	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Belgium			21	$1,100				
Canada	19,011	$1,754,460	2,226	250,443	947	$156,083	970	$188,005
France	155	18,353	440	43,814				
Germany	980	31,914	79	4,105				
Italy	198	24,572	516	69,704	62	8,501		
Netherlands	39	1,314	258	11,855				
Norway	11,732	852,576	12,387	884,760	141	19,872	9	955
Poland and Danzig	219	8,779	734	41,043				
Sweden	84	3,555						
Switzerland							5	994
United Kingdom	24	11,773	2,041	134,536	2	300		
	[2]32,442	[2] 2,707,296	18,702	1,441,360	[3] 1,152	[3] 184,756	984	189,954

[1] Data on total imports in 1934 and 1933 are not strictly comparable due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

[2] Includes small quantities of other manganese alloys in 1933.

[3] Includes small quantities of chromium and zirconium-silicon and calcium silicide in 1933.

The exports of ferro-alloys are relatively unimportant. Ferromanganese and spiegeleisen usually constitute the greater part of the total exports, but in 1934 only 222 gross tons were exported compared with 47 tons in 1933. The exports of tungsten and ferrotungsten decreased from 381 gross tons in 1933 to 314 tons in 1934.

Ferro-alloys and ferro-alloy metals exported from the United States, 1932–34, by varieties

Variety of alloy	1932		1933		1934	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Ferromanganese [1] } Spiegeleisen [1] }	33	$2,369	47	$3,393	222	$12,580
Tungsten and ferrotungsten (including tungsten wire)	63	172,585	381	460,966	314	453,813

[1] Not separately classified.

STEEL

Production.—The following tables covering the production of steel were compiled by the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of Iron Age give market quotations of prices of steel billets and some of the leading forms of finished steel. The price of open-hearth steel billets at Pittsburgh in 1934 ranged from $26 to $29 a gross ton; in 1933 it was $26 a ton. Tank plates at Pittsburgh ranged from 1.7 to 1.85 cents a pound in 1934 and from 1.5 to 1.7 cents a pound in 1933. Structural shapes at Pittsburgh ranged from 1.7 to 1.85 cents a pound in 1934 and from 1.6 to 1.7 cents a pound in 1933. Hot-rolled annealed sheets, no. 24 gage, at Pittsburgh ranged from 2.25 to 2.65 cents a pound in 1934 and from 2 to 2.25 cents a pound in 1933.

The production of steel in 1934 was 26,055,289 gross tons, of which 23,531,105 tons were open-hearth, 2,162,357 tons Bessemer, 531 tons crucible, and 361,296 tons electric steel. In 1933 the production was 23,232,347 tons, of which 20,381,672 tons were open-hearth, 2,428,791 tons Bessemer, 681 tons crucible, and 421,203 tons electric steel.

Bessemer steel ingots and castings manufactured in the United States, 1930–34, by States, in gross tons

State	1930	1931	1932	1933	1934 [1]
Ohio	1,892,021	1,393,875	939,228	1,219,494	1,017,629
Pennsylvania	1,732,545	786,767	233,215	598,672	570,817
Illinois	718,104	420,569	250,983	379,483	299,157
Other States	692,789	422,235	108,650	231,142	274,754
	5,035,459	3,023,446	1,532,076	2,428,791	2,162,357

[1] The figures for 1934 include only that portion of the steel for castings which was produced in foundries operated by companies producing steel ingots.

Open-hearth steel ingots and castings manufactured in the United States, 1930–34, by States, in gross tons

State	1930	1931	1932	1933	1934 [1]
New England States	214, 425	175, 673	128, 227	227, 445	209, 547
New York and New Jersey	1, 764, 976	1, 144, 839	589, 945	907, 512	1, 086, 189
Pennsylvania	12, 488, 175	7, 384, 091	3, 506, 451	5, 733, 772	6, 390, 342
Ohio	7, 152, 526	4, 954, 069	2, 849, 170	5, 285, 122	5, 649, 785
Indiana	4, 742, 297	2, 746, 899	1, 428, 091	2, 649, 190	3, 098, 343
Illinois	2, 514, 799	1, 450, 637	695, 936	1, 407, 581	1, 642, 437
Other States	6, 171, 974	4, 653, 358	2, 709, 510	4, 171, 050	5, 454, 462
	35, 049, 172	22, 509, 566	11, 907, 330	20, 381, 672	23, 531, 105

[1] The figures for 1934 include only that portion of the steel for castings which was produced in foundries operated by companies producing steel ingots.

According to these tables, there was a decrease of 11 percent in the production of Bessemer steel, but an increase of 15 percent in that of open-hearth steel in 1934 compared with 1933; the total production of steel increased 12 percent. Of the total output in 1934, 90.3 percent was open-hearth, 8.3 percent Bessemer, and 1.4 percent other classes of steel.

Of the total output of open-hearth steel, 23,256,417 gross tons were made by the basic process and 274,688 tons by the acid process, compared with 20,057,146 tons of basic steel and 324,526 tons of acid steel in 1933.

The production of steel by the electric process decreased 14 percent compared with 1933.

Steel electrically manufactured in the United States, 1930–34, in gross tons

Year	Ingots	Castings	Total	Year	Ingots	Castings	Total
1930	307, 418	305, 181	612, 599	1933	299, 808	121, 395	421, 203
1931	235, 376	175, 566	410, 942	1934 [1]	349, 095	12, 201	361, 296
1932	141, 328	99, 783	241, 111				

[1] The figures for 1934 include only that portion of the steel for castings which was produced in foundries operated by companies producing steel ingots.

Figures for the total production of electric steel in 1934 include 299,236 tons of alloy-steel ingots and castings that were alloyed with nickel, vanadium, tungsten, chromium, molybdenum, and other metals compared with 296,210 tons (262,196 tons of ingots and 34,014 tons of castings) so alloyed in 1933.

Foreign trade in steel.—With American producers still enjoying competitive advantages formerly held by foreign producers due to dollar depreciation, exports of iron and steel showed a substantial increase in 1934 over 1933, and imports were received in smaller volume. Of the articles that constitute the bulk of the imports, steel bars, structural iron and steel, rails, tubular products, wire rods, and scrap were imported in 1934 in smaller quantities than in 1933.

Iron and steel imported for consumption in the United States, 1933–34

Article	1933		1934	
	Gross tons	Value	Gross tons	Value
Bar iron	534	$33,469	805	$53,403
Steel bars: Concrete reinforcement	2,632	56,780	1,276	32,742
Hollow bars, and hollow drill steel	960	116,736	918	121,536
Steel bars, n. e. s.	20,883	687,225	18,762	984,876
Boiler or other plate iron or steel	237	8,359	280	8,404
Steel ingots, blooms, slabs, etc.	1,039	57,714	2,136	113,550
Sheets of iron or steel, common or black, and boiler or other plate iron or steel	6,020	200,316	2,736	119,618
Sheets and plates (including steel circular-saw plates) and steel, n. s. p. f.	3,246	88,243	1,624	84,344
Tin plates, terneplates, and taggers tin	261	40,185	126	31,821
Structural iron and steel	29,296	610,387	25,023	727,099
Rails and bars for railways and rail braces	5,967	151,339	2,967	79,634
Railway fishplates or splice bars, and tieplates	437	25,271	106	6,325
Cast-iron pipe and fittings	910	26,116	65	1,834
Other pipes and tubes	8,825	886,432	4,808	590,328
Barbed wire	8,301	381,624	8,859	493,103
Round iron and steel wire	2,723	340,160	2,442	391,607
Bailing wire	347	14,854	136	6,515
Flat wire and steel strips not thicker than ¼ inch, and not over 16 inches wide	1,024	550,538	1,805	1,008,499
Wire rope and wire strand	1,714	242,892	1,512	256,940
Wire rods, nail rods, and flat rods	13,339	748,163	10,657	776,398
Hoop or band iron or steel, cut to lengths, for bailing	4,012	105,705	2,007	78,421
Hoop, bands, strips, or scroll iron or steel, n. e. s.	17,127	501,405	15,857	566,645
Nails	6,472	518,351	7,016	578,059
Iron and steel scrap	56,133	429,489	44,421	358,363
Castings and forgings, n. e. s.	1,443	203,502	1,392	232,111

Some of the larger increases in exports of semimanufactured and manufactured iron and steel in 1934 over 1933 were recorded for steel bars, tin plate and terneplate, unfabricated plates, black steel sheets, structural shapes, rails, and tubular products. The exports of iron and steel scrap increased from 773,406 gross tons in 1933 to 1,835,564 tons in 1934.

Iron and steel exported from the United States, 1933–34

Article	1933		1934	
	Gross tons	Value	Gross tons	Value
Semimanufactures:				
Steel ingots, blooms, billets, slabs, and sheet bars	3,159	$114,035	19,586	$576,860
Iron and steel bars and rods:				
Iron bars	674	55,254	1,004	83,655
Steel bars	22,251	1,131,295	42,960	2,126,320
Alloy-steel bars	1,797	267,311	2,910	525,351
Wire rods	16,877	608,079	23,732	814,678
Iron and steel plates, sheets, skelp, and strips:				
Boiler plates	827	40,025	1,564	106,711
Other plates, not fabricated	12,929	591,790	34,228	1,505,422
Skelp iron or steel	23,260	822,392	57,367	2,099,281
Iron or steel sheets, galvanized	53,856	3,681,783	68,539	4,630,247
Steel sheets, black	37,078	2,464,826	91,003	6,025,326
Iron sheets, black	2,751	195,940	4,325	316,604
Strip iron and steel, cold rolled	8,032	624,399	14,171	1,110,294
Hoop, band, and scroll iron or steel	12,218	603,176	15,137	822,718
Tin plate and terneplate	95,239	7,650,419	184,651	16,872,564
Manufactures—steel-mill products:				
Structural iron and steel:				
Structural shapes:				
Not fabricated	14,089	535,364	31,392	1,321,587
Fabricated	13,893	939,967	18,173	1,391,074
Plates fabricated, punched or shaped	1,400	82,418	2,606	134,790
Metal lath	1,006	135,439	1,113	159,497
Frames, sashes, and sheet piling	3,045	183,739	2,896	178,393
Railway track material:				
Rails for railways	41,481	1,226,929	69,159	2,121,372
Rail joints, splice bars, fishplates, and tieplates	9,128	478,010	10,632	596,402
Switches, frogs, and crossings	755	94,157	1,756	263,269
Railroad spikes	2,375	192,112	3,254	224,873
Railroad bolts, nuts, washers, and nut locks	1,278	174,244	1,287	161,557
Tubular products:				
Boiler tubes	3,919	483,392	8,245	1,084,555
Casing and oil-line pipe	39,206	3,430,620	57,111	5,665,673
Welded black pipe	15,281	1,017,185	21,660	1,621,227
Welded galvanized pipe	20,457	1,477,441	24,496	2,030,996
Malleable-iron screwed pipe fittings	2,500	665,904	2,980	954,946
Cast-iron screwed pipe fittings	1,330	246,154	2,641	479,174
Cast-iron pressure pipe and fittings	6,622	323,323	10,315	580,158
Cast-iron soil pipe and fittings	3,658	232,383	4,746	376,189
Wire and manufactures:				
Barbed	29,045	1,507,931	36,076	2,052,840
Galvanized wire	12,367	639,124	21,189	1,236,258
Iron or steel wire, uncoated	9,552	569,083	15,330	977,584
Wire rope	2,210	508,254	2,681	715,573
Woven-wire fencing and screen cloth	1,627	305,017	2,336	425,157
All other	2,874	658,493	4,771	1,020,332
Nails and bolts (except railroad):				
Horseshoe nails	592	134,812	784	185,705
Wire nails	10,249	509,065	13,200	747,750
All other nails, including tacks and staples	3,374	341,041	4,151	431,462
Bolts, nuts, rivets, and washers (except railroad)	3,681	808,910	5,145	1,339,766
Castings and forgings:				
Horseshoes	144	22,977	174	20,452
Iron and steel, including car wheels and axles	12,274	1,294,047	20,853	2,275,378
Advanced manufactures:				
Househeating boilers and radiators		151,517		215,920
Tools:				
Axes		378,767		547,562
Hammers and hatchets		80,277		139,541
Saws, wood and metal cutting		802,930		860,720
Shovels and spades		101,280		163,680
All other tools		3,708,626		5,826,533

BAUXITE AND ALUMINUM

By C. E. Julihn

SUMMARY OUTLINE

World production of aluminum increased moderately in 1934 in response to improved consumption that also is believed to have permitted an appreciable decline of stocks. Production of bauxite likewise increased moderately. The quoted price of aluminum remained unchanged, but the price for settlements within the European cartel has been reduced substantially. A comparison of salient statistics of bauxite and aluminum follows:

Salient statistics of the bauxite and aluminum industries, 1933–34

	1933	1934	Increase (+) or decrease (−) per cent
Bauxite:			
World production (exclusive of U. S. S. R.)—metric tons	1, 048, 000	[1] 1, 100, 000	[1] +5. 0
United States:			
Production—do	156, 651	160, 371	+2. 4
Do—long tons	154, 176	157, 838	+2. 4
Value—dollars	923, 259	1, 129, 053	+22. 3
Price per ton—do	5. 99	7. 15	+19. 4
Imports—long tons	149, 548	166, 653	+11. 4
Exports—do	21, 760	51, 415	+136. 3
Aluminum:			
World production—metric tons	142, 000	170, 000	+19. 7
United States:			
Production—do	38, 613	33, 646	−12. 9
Do—short tons	42, 563	37, 089	−12. 9
Value—dollars	16, 174, 000	14, 094, 000	−12. 9
Price per pound, new, 98–99 percent—cents	22. 9	22. 9	----------
Secondary production—short tons	33, 500	46, 400	+38. 5
Imports, value—dollars	3, 213, 954	4, 038, 374	+25. 7
Exports, value—do	1, 329, 027	2, 381, 468	+79. 2

[1] Estimated.

4744—35——28

BAUXITE

The bauxite output of the United States was 157,838 long tons, valued at $1,129,053, in 1934, compared with 154,176 long tons, valued at $923,259, in 1933. The increase thus totaled 3,662 tons (about 2 percent). This represents, however, a decline of about 57 percent since 1929. The percentage decline in total value from 1929 was about 50 percent.

Bauxite is at present the only commercial ore of aluminum, except that in Italy alumina is extracted, in conjunction with other substances, from rocks containing leucite. This almost exclusive use of bauxite for production of aluminum is due not only to its high content of alumina but to its low content of silica, because silica is soluble in the hot alkaline solutions by means of which alumina (Al_2O_3) is extracted most easily from ores.

Although there is more aluminum than iron in the earth's crust, and more of it than of any other element except oxygen and silicon, it originates in igneous rocks as a constituent of feldspars, in which it is combined chemically with silica. The sedimentary rocks, being derived in turn from igneous rocks, likewise contain aluminum associated with silica, either in chemical combination or intimately mixed with it. Thus the vast quantities of clay that result from decomposition of feldspars contain high percentages of aluminum as well as much silica. Heretofore clays and feldspars have not been able to compete with bauxite as a commercial source of aluminum by known processes.

Typical bauxites now worked throughout the world contain 2 to 5 percent silica, 10 to 30 percent combined water, 55 to 65 percent alumina, and 25 to less than 1 percent ferric oxide, together with 1 to 2 percent titanium oxide. Bauxites of the United States probably average about 58 percent alumina and 5 to 6 percent silica. Those of the Guianas average somewhat higher in alumina and lower in silica. Bauxite from British Guiana contains about 2.5 percent iron oxide, while that from Surinam (Dutch Guiana) contains about 5 percent.

Approximately one-fourth of the bauxite produced in the world usually is consumed in manufacturing chemicals, refractories, abrasives, and cement and filtering oil, the balance being used in the production of aluminum. These relations, however, have been disturbed somewhat in recent years by a larger proportionate decline in the production of aluminum, especially in the United States.

Trends of bauxite production for the United States and for the world over more than two decades compared with shipments into the United States and domestic exports are shown in figure 21.

Aluminum is not made directly from bauxite but from alumina (Al_2O_3), which is extracted from bauxite by chemical processes; the alumina then is reduced to aluminum in electric furnaces. About 4 tons of bauxite are required to make 1 ton of aluminum because 2 tons of bauxite yield about 1 ton of alumina and 2 tons of alumina about 1 ton of aluminum.

At East St. Louis alumina is extracted from the bauxites of Arkansas and Surinam (Dutch Guiana), but it is shipped to reduction plants established where cheap water power is available. Such plants are located at Niagara Falls and Massena, N. Y.; Alcoa near

Knoxville, Tenn.; and Badin, N. C. Alumina is also exported from East St. Louis to Canada and to Norway, where cheap hydroelectric power is available.

Bauxite produced in the United States, 1930–34

Year	Alabama and Georgia		Arkansas		Total	
	Long tons	Value f. o. b. mine	Long tons	Value f. o. b. mine	Long tons	Value f. o. b. mine
1930	15,339	$104,908	315,273	$1,823,389	330,612	$1,928,297
1931	9,198	59,179	186,697	1,081,450	195,895	1,140,629
1932	6,570	40,471	89,779	507,697	96,349	548,168
1933	11,997	69,541	142,179	853,718	154,176	923,259
1934	12,074	71,991	145,764	1,057,062	157,838	1,129,053

The domestic production of bauxite—157,838 long tons—originated chiefly in Arkansas, which produced over 92 percent of the total in 1934; Alabama and Georgia together provided less than 8 percent.

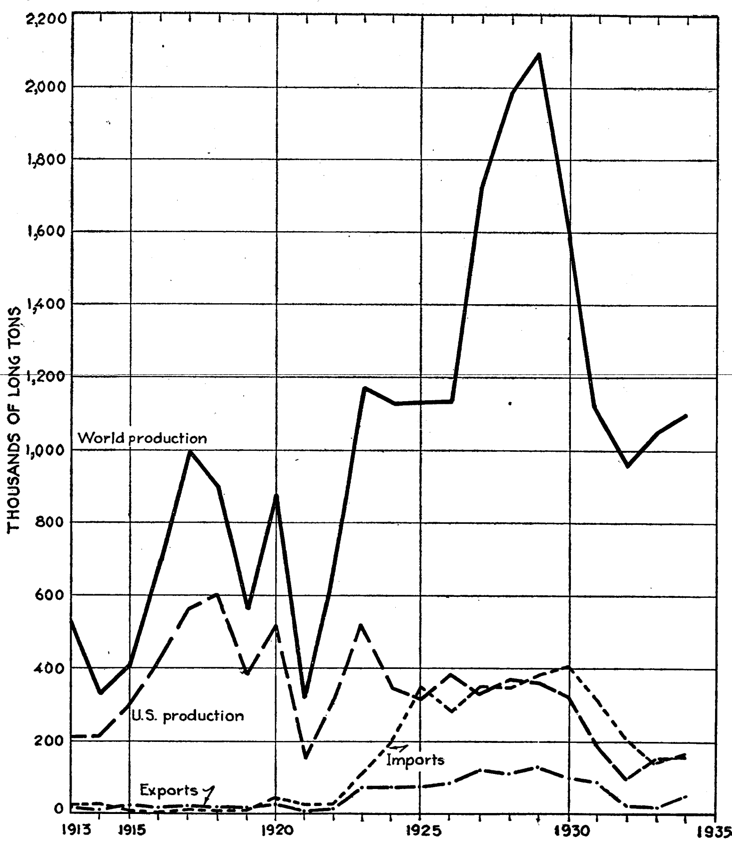

FIGURE 21.—Trends in bauxite production in the United States and in the world, 1913–34, compared with shipments into the United States and domestic exports.

Arkansas shipped 145,764 long tons of bauxite in 1934 from seven mines—the Bauxite, Cargill, Standard, and Patricia No. 1 in Saline

County and the Dixie No. 2, Rauch, and the England in Pulaski County. This represented an increase of 2.5 percent compared with 1933, resulting from an increase of 43 percent in shipments from Saline County and a decline of 49 percent from Pulaski County. The former county provided the bulk of the tonnage.

In Alabama bauxite was shipped in 1934 from the Eufaula and the Lennig mines in Barbour County. Shipments were 18 percent greater than in 1933. In Georgia bauxite was shipped in 1934 from the Hatton and Easterlin mines in Sumter County. Shipments were 22 percent less than in 1933. The combined shipments from Alabama and Georgia were 12,074 tons, all of which was taken by the chemical industry.

The first bauxite produced in the United States was obtained in 1889 from deposits in the north Georgia field, and in 1891 bauxite first was produced from the Alabama deposits. Virtually all the bauxite mined in the United States until 1899 came from these two States. In 1896 the first shipments were made from Arkansas deposits, but it was not until 1900 that their influence was felt. In 1907 the first bauxite from Tennessee deposits was shipped. The total domestic production of bauxite recorded from 1889 to 1934, inclusive, is 8,434,657 long tons.

Prices.—The largest consumers of bauxite in the United States are also the chief producers, and consumers who do not own deposits usually contract for their supply of bauxite over considerable periods. The market for casual or new production therefore is narrow, and prices are quoted through a wide range. Producers of domestic bauxite reported sales during 1934 at prices ranging from $3.75 to $12 a long ton. The average for Arkansas bauxite was $7.25 a ton, for Alabama and Georgia $5.96, and for United States $7.15. The quoted prices [1] for bauxite were as follows: Domestic—Chemical ore, crushed and dried, 55 to 58 percent Al_2O_3 and 1.5 to 2.5 percent Fe_2O_3, $6 to $7.50 a long ton f. o. b. Alabama and Arkansas mines. Foreign—Dalmatian, 50 to 55 percent Al_2O_3 and 1 to 3 percent SiO_2, $4.50 to $6; Istrian, 54 to 57 percent Al_2O_3 and 3 to 5 percent SiO_2, $5.50 to $6; and French, 56 to 59 percent Al_2O_3 and 2 to 4 percent SiO_2, $5.50 to $6.50 a metric ton c. i. f. Atlantic ports.

Under the Tariff Act of 1930 crude bauxite is dutiable at the rate of $1 a ton, and alumina hydrate or refined bauxite at one-half cent a pound. (See par. 6, schedule 1; and par. 207, schedule 2.)

Market and uses.—The principal market for bauxite is east of the Mississippi River; it is sold chiefly to the manufacturers of aluminum, abrasives, commercial chemicals, and refractories. The manufacturers of alumina cements are supplied largely by imported bauxite. High-alumina (diaspore) clays produced in Missouri now are used in the manufacture of refractories and sold according to their alumina content; three grades, containing 55, 65, and 70 percent alumina (Al_2O_3), are handled regularly. Information regarding its production will be found in the Minerals Yearbook chapter on Clay.

Some makers of refractories and of aluminum chemicals are using increasing quantities of clay as a crude material in place of bauxite.

The principal sales of domestic bauxite in 1934 were made again to chemical industries, which took 67,153 tons (43 percent) of the total. For making aluminum 55,630 tons (35 percent) and for use

[1] Metal and Mineral Markets, vol. 5, 1934.

in abrasives 34,580 tons (22 percent) were shipped, a striking change from the ratios of demand in 1928, when 58 percent of domestic production was for use in manufacture of aluminum, 22 percent for chemicals, and 19 percent for abrasives. The year 1934 witnessed substantial recovery of consumption for aluminum and abrasives above that of 1933. Consumption for aluminum increased 20 percent and for abrasives 87 percent above that in 1933, but consumption for chemicals decreased 25 percent. Makers of refractories took 20,294 short tons of high-alumina (diaspore) clay in 1934. The aluminous abrasives are used largely in powdered and granulated material for grinding wheels and sandpaper.

Domestic bauxite sold by producers to industries in the United States, 1930–34, in long tons

Year	Aluminum	Chemical	Abrasive [1]	Cement and refractory [1]	Total	Year	Aluminum	Chemical	Abrasive [1]	Cement and refractory [1]	Total
1930	179,869	67,690	82,116	937	330,612	1933	46,506	89,226	18,444	--------	154,176
1931	83,340	58,424	53,631	500	195,895	1934	55,630	67,153	34,580	475	157,838
1932	28,899	61,838	5,612	--------	96,349						

[1] Small quantity of bauxite sold to makers of refractories probably included under "Abrasive."

Value of aluminum and aluminum salts made from bauxite in the United States, 1930–34

Year	New aluminum	Aluminum salts	Year	New aluminum	Aluminum salts
1930	$50,961,000	$10,245,063	1933	$16,174,000	$8,816,681
1931	37,284,000	8,736,030	1934	14,094,000	9,109,149
1932	20,453,000	7,669,075			

Aluminum salts.—Manufacturers of aluminum salts reported a consumption of 120,600 long tons of bauxite in 1934 with an average value of $11.09 a ton at the plant compared with 123,300 tons (revised figure) in 1933, with an average value of $11.08 a ton (revised figure). An unrecorded quantity of high-alumina clay, 4,312 short tons of alumina hydrate, and some aluminum also were used in the preparation of aluminum salts. These figures do not include the bauxite made into alumina and sodium aluminate as a preliminary step in the manufacture of aluminum. Neither do the figures in the following tables include the alumina and sodium aluminate made as a preliminary step in the manufacture of aluminum.

Aluminum salts, produced in the United States, shipped in 1933–34

Salt	1933				1934			
	Number of producers reporting	Short tons	Value		Number of producers reporting	Short tons	Value	
			Total	Average			Total	Average
Alum:								
Ammonia	5	4,039	$205,791	$51	5	4,859	$240,466	$49
Potash	3	1,869	95,792	51	3	2,869	145,674	51
Other	-------	-------	-------	-------	1			
Sodium-aluminum sulphate	3	18,750	1,022,345	55	3	17,767	967,766	54
Aluminum chloride:								
Liquid	5	1,437	76,247	53	5	877	45,857	52
Crystal	2	3,328	308,334	93	3	443	46,261	104
Anhydrous	4				4	3,984	495,923	124
Aluminum sulphate:								
Commercial:								
General	11	305,001	6,077,410	20	11	306,532	6,091,284	20
Municipal	10	9,696	147,716	15	10	10,227	170,674	17
Iron-free	7	15,142	465,769	31	7	14,653	463,140	32
Other aluminum salts and hydrate	[1] 5	6,325	417,277	-------	[1] 4	6,030	442,104	-------
	-------	365,587	8,816,681	-------	-------	368,241	9,109,149	-------

[1] 1933: 3 producers of alumina, 2 producers of sodium aluminate, and 1 producer of aluminum acetate; 1934: 3 producers of alumina and 2 producers of sodium aluminate.

The following table shows the recent record of actual production of aluminum salts to indicate the difference between these figures and those for shipments shown in the preceding table:

Aluminum salts produced in the United States, 1930–34, in short tons

Salt	1930	1931	1932	1933	1934
Alum:					
Ammonia	4,489	4,085	4,032	4,156	4,739
Potash	1,984	2,404	1,198	1,858	3,003
Other	-------	-------	-------	-------	
Sodium-aluminum sulphate	14,776	15,945	16,428	18,941	17,742
Aluminum chloride:					
Liquid	3,323	1,589	1,998	1,595	1,381
Crystal	827	5,518	2,439	3,261	4,455
Anhydrous	11,543				
Aluminum sulphate:					
Commercial	314,870	299,864	271,537	316,608	317,535
Iron-free	23,217	14,636	14,029	16,016	14,852
Other aluminum salts and hydrate	3,915	3,044	2,421	5,534	6,457
	378,944	347,085	314,082	367,969	370,164

Aluminum salts shipped in, imported into, and exported from the United States, 1930–34

Year	Domestic shipments		Imports		Exports (aluminum sulphate) [1]	
	Short tons	Value	Short tons	Value	Short tons	Value
1930	373,051	$10,245,063	2,058	$90,472	25,255	$573,234
1931	351,071	8,736,030	1,770	82,337	27,668	568,490
1932	315,374	7,669,075	1,505	65,859	21,550	462,954
1933	365,587	8,816,681	1,094	51,490	28,270	543,945
1934	368,241	9,109,149	726	38,620	30,881	594,440

[1] Also "other aluminum compounds" as follows: 1930, 1,009 short tons, valued at $194,503; 1931, 875 tons, $170,585; 1932, 326 tons, $58,789; 1933, 428 tons, $70,011; 1934, 488 tons, $93,440.

Bauxite producers in the United States in 1934

American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York, N. Y.
Crawford Bauxite Co., Bauxite, Ark.
Crouch Mining Co., Inc., P. O. Box 35, Bridge Station, Niagara Falls, N. Y.
Dixie Bauxite Co., Inc., Sweet Home Ark.
Benjamin Easterlin, Americus, Ga.
Charles Lennig & Co., Inc., 222 West Washington Square, Philadelphia, Pa.
Republic Mining & Manufacturing Co., 230 Park Avenue, New York, N. Y.
Standard Bauxite & Chemical Co., Inc., Bauxite, Ark.

Consumers of bauxite in the United States in 1934

Aluminum Ore Co., East St. Louis, Ill.
American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York, N. Y.
Atlas Lumnite Cement Co., 208 South La Salle Street, Chicago, Ill.
Birmingham Water Works Co., Birmingham, Ala.
Board of Public Utilities, Kansas City, Kans.
Brown Co., Berlin, N. H.
Bureau of Water Supply, Baltimore, Md.
Calumet Chemical Co., Joliet, Ill.
The Carborundum Co., Niagara Falls, N. Y.
City of Columbus Purification Works, Columbus, Ohio.
Columbus Water Works, Columbus, Ga.
Dalecarlia Filter Plant, Washington, D. C.
Exolon Co., Blasdell, N. Y.
Federal Abrasives Co., Anniston, Ala.
General Abrasive Co., Inc., Niagara Falls, N. Y.
General Chemical Co., 40 Rector Street, New York, N. Y.
General Refractories Co., 106 South Sixteenth Street, Philadelphia, Pa.
Grasselli Chemical Co., Cleveland, Ohio.
Gulf Refining Co., Gulf Building, Pittsburgh, Pa.
Harbison-Walker Refractories Co., Pittsburgh, Pa.
William F. Jobbins, Inc., Aurora, Ill.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Charles Lennig & Co., Inc., 222 West Washington Square, Philadelphia, Pa.
Louisiana Chemical Co., Inc., Bastrop, La.
Massillon Stone & Fire Brick Co., Massillon, Ohio.
Merrimac Chemical Co., 148 State Street, Boston, Mass.
Metropolitan Utilities District, Omaha, Nebr.
Norton Co., Worcester, Mass. (also Niagara Falls, N. Y.).
Paper Makers Chemical Corporation, Wilmington, Del.
Passiac Valley Water Commission, 141 Ellison Street, Paterson, N. J.
Pennsylvania Salt Manufacturing Co., Widener Building, Philadelphia, Pa.
Sacramento Filtration Works, Sacramento, Calif.
Stauffer Chemical Co., 624 California Street, San Francisco, Calif.
Vanadium Corporation of America, Bridgeville, Pa.
Water Department of Kansas City, Kansas City, Mo.
Welch Chemical Co., 8 East Long Street, Columbus, Ohio.

Imports and exports.—Both imports and exports of bauxite increased in 1934, imports moderately from about 150,000 tons in 1933 to about 167,000 tons in 1934 (11 percent) while exports more than doubled, with an increase from about 22,000 tons in 1933 to about 51,000 tons in 1934. The total supply, including domestic production and the excess of imports over exports, decreased slightly—from 281,964 tons in 1933 to 273,076 tons in 1934. The 1934 figure was only 43 percent of that in 1930, which totaled 635,786 tons.

The higher unit value of exports compared with imports is due to the fact that they consist chiefly of so-called "concentrates"—purified alumina extracted from bauxite for use in the electrical reduction of aluminum. This alumina is extracted from bauxite at East St. Louis and shipped, chiefly to Canada, for reduction to aluminum.

The principal source of imports was Surinam, from which 100,175 long tons of bauxite were imported in 1934.

Bauxite imported into and exported from the United States, 1930–34

Year	Imports for consumption		Exports (including bauxite concentrates)		Year	Imports for consumption		Exports (including bauxite concentrates)	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1930	409, 678	$1, 995, 941	104, 504	$3, 776, 774	1933	149, 548	$899, 696	21, 760	$645, 688
1931	306, 490	1, 495, 577	88, 370	3, 309, 208	1934	166, 653	1, 201, 710	51, 415	1, 039, 955
1932	205, 620	1, 042, 829	28, 474	1, 162, 238					

ALUMINUM

New aluminum produced in the United States in 1934 totaled 74,177,000 pounds (37,088 short tons) valued at $14,094,000, representing decreases of 13 percent both in quantity and total value compared with 1933. The total drop from the maximum domestic production of aluminum attained in 1930 was 68 percent. According to statistics collected by J. P. Dunlop, of the Bureau of Mines, 46,400 short tons of secondary aluminum were recovered in 1934, including the aluminum content of casting alloys. This exceeds by 25 percent the domestic production of virgin aluminum, although it is only 41 percent of the quantity of virgin aluminum produced in 1930. The combined domestic production of new aluminum and of secondary aluminum recovered as metal and in alloys thus totaled 83,488 tons in 1934, 44.4 percent of the total being new metal and 55.6 percent secondary or recovered material. Including excess of imports over exports but exclusive of stocks the aluminum supply was about 89,000 tons.

Aluminum produced in the United States, 1930–34

Year	Primary metal		Secondary metal		Year	Primary metal		Secondary metal	
	Pounds	Value	Pounds	Value [1]		Pounds	Value	Pounds	Value [1]
1930	229, 035, 000	$50, 961, 000	77, 200, 000	$17, 177, 000	1933	85, 126, 000	$16, 174, 000	67, 000, 000	$15, 343, 000
1931	177, 544, 000	37, 284, 000	60, 600, 000	12, 726, 000	1934	74, 177, 000	14, 094, 000	92, 800, 000	17, 632, 000
1932	104, 885, 000	20, 453, 000	48, 000, 000	10, 992, 000					

[1] 1930–31: Value of secondary aluminum based on average price as reported to Bureau of Mines; 1932–33: Based on average price of 22.9 cents a pound; 1934: Based on average price as reported to Bureau of Mines.

Figure 22 shows the primary aluminum produced in the United States and in the world, 1913–34, compared with imports into the United States and with domestic consumption, exports, secondary production, and trend of the average New York quoted price (No. 1 virgin 98–99 percent).

Price.—According to the Engineering and Mining Journal the domestic price of new aluminum ingot, 99 percent pure, was maintained at 23.3 cents a pound throughout 1934. The open-market quotation at New York for virgin metal, 99 percent pure, as reported by American Metal Market, declined from 23.30 cents a pound in January to 20.5 cents in November and December; the yearly average was given as 21.58 cents.

Consumption and uses.—Consumption of aluminum increased in 1934, but precise data indicating its extent are not available, though stocks are reported to have decreased.

In less than half a century aluminum has developed from a mere curiosity to rank as one of the most important industrial metals, especially important by reason of its light weight but with an astonishingly wide variety of uses due to its other properties as well. In this expansion of the use of aluminum there undoubtedly is exhibited an accelerated version (compressed into an exceedingly brief period,

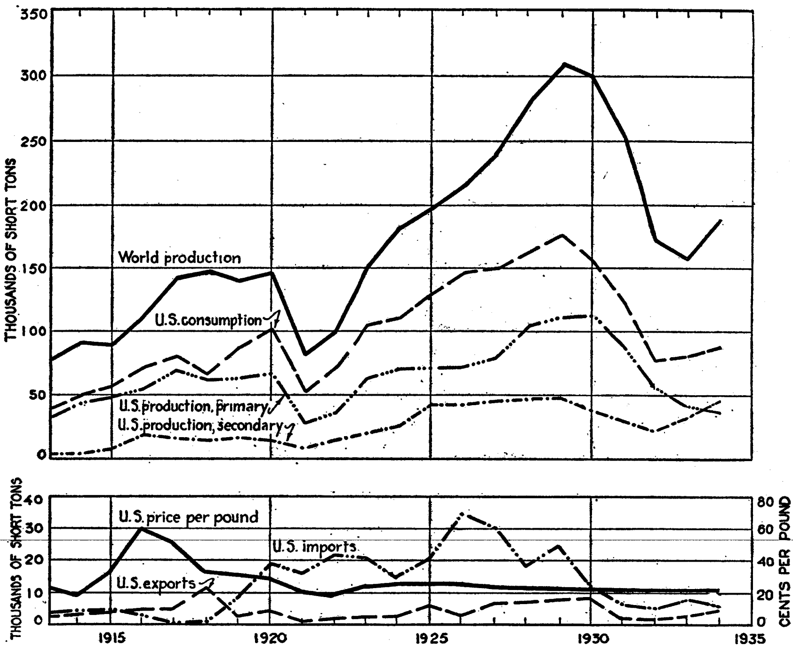

FIGURE 22.—Primary aluminum produced in the United States and in the world, 1913–34, compared with imports into the United States and with domestic consumption, exports, secondary production, and trend of the average New York quoted price (No. 1 virgin 98–99 percent).

the history of which is well-known) of the way in which the use of the earlier metals must have developed, with almost unbelievable slowness, through 40 or more centuries. One use led to another as understanding grew regarding the properties of the metal and the manner in which it might be worked and fashioned. It seldom is realized that long after aluminum began to be produced in substantial quantities its commercial utilization still involved many difficult problems, especially as to the manner of its working. It was only recently, for example, that the making of strong aluminum alloys and the nature of age-hardening were understood.

Aluminum is marketed in ingots, plates, sheets, bars, rods, structural shapes, die and sand castings, round, square, flat and hexagonal wire, rivets, bolts, nuts, screen, perforated sheets, foil, and powder. From these is evolved a wide variety of manufactures ranging from kitchen utensils, tableware, bottle caps, drums, barrels, collapsible tubes, shingles, corrugated sheets, and paints to building trim, gigantic power cranes, structural members of bridges, and streamlined cars and trains.

Recently a great expansion of architectural uses of aluminum began. Now there is greater emphasis upon further development of its use in transportation. Aluminum obviously commands an assured position in aviation because in aircraft minimum weight is indispensable.

In the past year one of the railroads completed a three-car streamline train built chiefly of aluminum. A six-car aluminum train constructed later was reported to weigh less than half as much as a comparable train of ordinary type.

Other reported developments in transportation equipment using aluminum include street and subway cars, coach and sleeping cars, and hopper cars. In this field aluminum has a strong competitor in the finer alloy steels.

Much interest attaches to recent development of protective finishes for aluminum based upon the provision of an oxide coating or film. Beautiful and durable effects have been obtained.

An aluminum-magnesium-silicide alloy developed for architectural purposes is reported to have proved extremely resistant to salt-water corrosion.

Imports and exports.—Aluminum imports increased 26 percent in total value during the year—from $3,213,954 in 1933 to $4,038,374 in 1934. Imports of aluminum metal, scrap, alloy, etc., increased 22 percent in quantity in 1934 compared with 1933, and imports of aluminum powders and foil decreased 37 percent in quantity. Changes in the other classifications were minor.

Aluminum exports increased 79 percent in value—from $1,329,027 in 1933 to $2,381,468 in 1934. Exports of crude and semicrude aluminum increased 47 percent in quantity in 1934 compared with 1933; exports of tubes, moldings, castings, and other shapes increased 13 percent in quantity.

Aluminum imported for consumption in the United States, 1932–34, by classes

Class	1932		1933		1934	
	Pounds	Value	Pounds	Value	Pounds	Value
Crude and semicrude:						
Crude form, scrap, alloy, etc	8,064,830	$1,310,228	15,077,597	$2,699,700	18,371,690	$3,561,833
Plates, sheets, bars, rods, circles, squares, etc	119,883	29,227	169,099	46,738	219,901	62,700
	8,184,713	1,339,455	15,246,696	2,746,438	18,591,591	3,624,533
Manufactures:						
Leaf (5½ by 5½ inches)	(1)	16,669	(1)	24,923	(1)	57,532
Bronze powder and powdered foil	598,417	159,831	587,927	173,948	250,055	96,598
Foil less than 0.006 inch thick	722,762	198,460	609,930	185,554	504,415	167,952
Powder in leaf (5½ by 5½ inches)			(2)	1,536	(2)	602
Table, kitchen, and hospital utensils, and other similar hollow ware	130,792	53,084	101,755	44,959	96,688	56,910
Other manufactures	(3)	54,703	(3)	36,596	(3)	34,247
		482,747		467,516		413,841
Grand total		1,822,202		3,213,954		4,038,374

[1] 1932: 13,723,695 leaves; 1933: 14,446,166 leaves; 1934: 24,905,941 leaves; equivalent in pounds not recorded.
[2] 1933: 430,750 leaves; 1934: 117,066 leaves; equivalent in pounds not recorded.
[3] Quantity not recorded.

Aluminum imported for consumption in the United States, 1930–34

Year	Crude and semicrude [1] Pounds	Crude and semicrude [1] Value	Manufactures of [2]	Total value	Year	Crude and semicrude [1] Pounds	Crude and semicrude [1] Value	Manufactures of [2]	Total value
1930	25,461,179	$4,689,521	$596,063	$5,285,584	1933	15,246,696	$2,746,438	$467,516	$3,213,954
1931	14,832,807	2,539,756	670,989	3,210,745	1934	18,591,591	3,624,533	413,841	4,038,374
1932	8,184,713	1,339,455	482,747	1,822,202					

[1] Includes crude aluminum, plates, sheets, wire, etc.
[2] Includes aluminum leaf, kitchen utensils, and all other manufactures of aluminum.

Domestic aluminum exported from the United States, 1933–34, by classes

Class	1933 Pounds	1933 Value	1934 Pounds	1934 Value
Crude and semicrude:				
Ingots, scrap, and alloys	5,514,759	$539,130	8,052,548	$1,141,808
Plates, sheets, bars, strips, and rods	192,902	60,831	313,009	109,399
	5,707,661	599,961	8,365,557	1,251,207
Manufactures:				
Tubes, moldings, castings, and other shapes	454,200	160,325	513,847	208,397
Table, kitchen, and hospital utensils	(1)	197,333	(1)	297,056
Other manufactures of aluminum	(1)	371,408	(1)	624,808
	(1)	729,066	(1)	1,130,261
Grand total	(1)	1,329,027	(1)	2,381,468

[1] Quantity not recorded for table, kitchen, and hospital utensils and other manufactures.

Aluminum and manufactures of aluminum exported from the United States, 1930–34

Year	Crude and semicrude [1] Pounds	Crude and semicrude [1] Value	Manufactures	Total value	Year	Crude and semicrude [1] Pounds	Crude and semicrude [1] Value	Manufactures	Total value
1930	17,329,511	$3,915,582	[2] $3,206,272	$7,121,854	1933	5,707,661	$599,961	[2] $729,066	$1,329,027
1931	4,700,878	985,870	[2] 1,868,875	2,854,745	1934	8,365,557	1,251,207	[2] 1,130,261	2,381,468
1932	4,436,690	468,792	[2] 983,583	1,452,375					

[1] Includes ingots, metal and alloys, plates and sheets, etc.
[2] Tubes, moldings, castings, and other shapes exported amounted to 1,864,308 pounds in 1930, 1,292,400 pounds in 1931, 839,043 pounds in 1932, 454,200 pounds in 1933, and 513,847 pounds in 1934; figures for quantity of table, kitchen, or hospital utensils and other manufactures exported are not recorded.

The preceding tables of imports and exports in 1934 indicate that the total imports for which the weights are recorded were 9,721 short tons and the total exports 4,440 tons. The excess of imports over exports thus accounted for amounts to 5,281 tons, indicating an approximate total supply of 42,369 tons of aluminum, other than domestic secondary, for domestic consumption.

FOREIGN BAUXITE AND ALUMINUM INDUSTRIES

World production of bauxite.—World production of bauxite in 1934, exclusive of Russian bauxite, is estimated at 1,100,000 metric tons compared with 1,048,000 tons in 1933 and 969,000 tons in 1932. The reported Russian production of aluminum would have required approximately 18,000 tons of bauxite in 1933 and 58,000 tons in 1934, all of which must have been of domestic origin, presumably from Tikhvin. The world totals may therefore be estimated as approximately 1,066,000 tons in 1933 and 1,158,000 tons in 1934.

World production of bauxite, 1930–34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1930	1931	1932	1933	1934
Australia:					
New South Wales		199		333	(1)
Victoria	802	1,406	1,147	681	(1)
British Guiana [2]	121,536	127,103	63,510	41,993	(1)
France	609,180	403,550	404,400	490,500	528,400
Germany	1,391		1,638	(1)	(1)
Greece	2,280	1,150	590	(1)	(1)
Hungary	31,696	89,556	111,558	72,425	(1)
India, British	2,554	4,367	4,539	1,092	(1)
Italy	161,187	67,369	86,553	94,818	(1)
Rumania	678	381	612	1,156	(1)
Spain	323		1,300	2,500	(1)
Surinam (Dutch Guiana)	264,556	173,154	126,513	103,977	(1)
United Kingdom: Northern Ireland	2,070	3,394	1,497	709	(1)
United States	335,918	199,039	97,895	156,651	160,371
Yugoslavia	94,700	64,842	67,086	80,855	(1)
	1,629,000	1,136,000	969,000	1,048,000	(1)

[1] Data not available. [2] Exports.

Europe now supplies about 70 percent, South America 15 percent, and North America 15 percent of the bauxite produced. In 1930 the corresponding percentages were 55, 24, and 21. In 1933 France produced 46 percent, the United States 15 percent, Surinam 10 percent, Italy 9 percent, Yugoslavia 8 percent, and Hungary 7 percent of the world output. These six countries thus provide about 95 percent of the world supply of bauxite.

World production of aluminum.—The world output of aluminum was approximately 170,000 metric tons in 1934 compared with 142,000 tons in 1933, North America supplying 29 percent in 1934 and Europe the balance. Germany provided 22 percent, the United States 20 percent, France nearly 10 percent, Canada and Norway 9 percent each, the U. S. S. R. (Russia) and Italy 8 percent each, and Great Britain 7 percent. These eight countries thus produce about 93 percent of the world aluminum supply.

World production of aluminum, 1933–34, by countries, in metric tons

Country	1933	1934 [1]	Country	1933	1934 [1]
Austria	2,100	2,100	Spain	1,154	1,200
Belgium	100	100	Sweden		200
Canada	16,155	15,500	Switzerland	7,500	8,100
France	14,495	16,300	U. S. S. R. (Russia)	4,400	14,400
Germany	18,932	37,158	United States	38,613	33,646
Great Britain	10,973	12,500			
Italy	12,072	12,800		142,000	170,000
Norway	15,384	15,500			

[1] Subject to revision.

NORTH AMERICA

Canada.—In 1934 Canada produced 15,500 metric tons of aluminum from imported raw materials, including alumina from the United States and bauxite from British Guiana, compared with 16,155 tons in 1933 and 17,781 tons in 1932. Canada has no domestic deposits of bauxite but has the cheap hydroelectric power required for economic production of aluminum.

Imports of bauxite for the first 11 months of 1934 were 76,150 tons compared with 49,327 tons in the corresponding period of 1933.

Exports of aluminum totaled 20,873 tons in 1934, of which more than half went to England. Exports in 1933 were 16,957 tons.

Greenland.—Greenland is the only source of natural cryolite, which formerly was required for the electrolyte in the electrical reduction of aluminum. Although natural cryolite now is replaced largely by synthetic cryolite and other fluorides it is still used in the initial stage of aluminum reduction.

Greenland's production has declined in recent years to less than 20,000 tons, all of which goes to Denmark for subsequent distribution through Europe and to North America.

SOUTH AMERICA

Among the best bauxite deposits of the world are those along the coasts of British Guiana and Surinam (Dutch Guiana). In Surinam they extend from 15 to as much as 100 miles back from the coast in the region of Paramaribo and are 10 to 50 feet thick. The British deposits are similar but occur in low hills 60 to 80 miles from the coast.

British Guiana.—The British Guiana bauxite is controlled largely by Aluminium, Ltd., through its subsidiary, the Demerara Bauxite Co., Ltd. These deposits provide the raw materials needed for aluminum production by Canada, though much of the bauxite may be shipped to the United States for extraction of the alumina destined for reduction in Canada.

The bauxite production of British Guiana was about 42,000 metric tons in 1933, compared with 127,000 tons in 1931.

Surinam (Dutch Guiana).—The bauxite of Surinam is chiefly controlled by the Aluminum Co. of America through its subsidiary, the Surinaamsche Bauxite Maatschappij. Shipments of bauxite in 1934 by Surinaamasche Bauxite Maatschappij totaled 103,611 metric tons. All of this bauxite goes to East St. Louis via New Orleans.

EUROPE

The Alliance Aluminium Cie., generally referred to as the Aluminum Cartel, includes the aluminum producers of Europe and Canada, but not the United States. It determines export quotas and the price of aluminum but permits free competition of aluminum manufactures. Recently the cartel reduced the price of aluminum, for internal settlements among its members, from £73 to £63, gold, per ton. The price originally established in 1926 was £105 but had declined to £80 in 1932.

France.—In 1934 France produced 528,400 metric tons of bauxite compared with 490,500 tons in 1933 and 404,400 tons in 1932. Nearly all of the 1934 production came from the Department of the Var.

Of the 1934 production 282,368 tons were exported, compared with 245,000 tons in 1933 and 212,487 tons in 1932. A decree of April 1935 forbids exportation from France of aluminum or alumina, but the prohibition does not include bauxite.

In 1934, 16,300 metric tons of aluminum were produced and in 1933, 14,495 tons.

Germany.—Bauxite production was revived in 1933 in the Vogelsberg district, where there had been some output during the World War. In 1934 the rate was increased to about 18,000 tons a year. Other available statistics on bauxite and aluminum in Germany are included in the following table:

Statistical summary of bauxite and aluminum in Germany, 1932–34, in metric tons

	1932	1933	1934
Bauxite imports from:			
France	(1)	114,100	120,450
Hungary	(1)	53,170	109,850
Yugoslavia	(1)	38,830	77,270
Other countries	(1)	32,962	18,894
Total	201,000	239,062	326,464
Aluminum:			
Smelter output	19,000	18,900	37,200
Net imports			2,039
Net exports	1,783	2,800	
Scrap imports	(1)	2,359	3,672
Supply	(1)	18,459	42,911
Consumption (estimated)	18,500	27,500	40,000

[1] Figures not available.

Promising results are reported to have been achieved in research for utilization of clays as a source of aluminum by the Institut für Metalhüttenwesen und Electrometallurgie in Aachen.

Because of increased aluminum consumption in Germany the cartel has increased its production quota to 55,000 metric tons a year. The present capacity of German plants has been published as 12,100 tons for Inn, 13,300 tons for Lauta, 15,900 tons for Erft, 8,280 tons for Bitterfeld, and 4,420 tons for Rheinfelden.

The German Government has prohibited the use of copper for new electrical transmission cables to enforce the use of aluminum. About 10,000 kilometers of aluminum cable are now in use compared with 17,000 kilometers of copper cable.

Hungary.—Hungary produced 72,425 metric tons of bauxite in 1933, 111,558 tons in 1932, and 89,556 tons in 1931, nearly all of which was exported. Its reserves of bauxite are large, but recent production has been so limited by competition that an endeavor is now being made to establish a domestic aluminum industry.

"Bauxiet Industrie", a newly-formed subsidiary of the Bauxit Trust, Zurich, is to build an alumina works, and an aluminum-reduction plant will be built at Csepel on the Danube River by the Manfred Weiss concern in cooperation with the Bauxit Trust.

Italy.—Italy produced 94,818 tons of bauxite in 1933 compared with 86,553 tons in 1932 and 67,369 tons in 1931.

Italy's production of aluminum in 1934 was 12,800 metric tons compared with 12,072 tons in 1933.

Liquidation of the Società Italiana dell' Alluminio, which has an annual production capacity of 6,000 tons of aluminum, has been proposed by the Montecatini Co., one of its joint owners. The German United Aluminum Works, the other owner, has refused assent.

Italy has prohibited imports of aluminum ingots and scrap because of excess domestic production which provides a surplus available for export.

Norway.—Norway, like Canada, has no deposits of bauxite but has cheap hydroelectric power and hence produces aluminum from imported bauxite and alumina. In 1934 combined imports of these raw materials, chiefly alumina, were 29,956 metric tons, compared with 20,798 tons in 1933 and 19,420 tons in 1932.

Production of aluminum in 1933 was 15,384 tons and that of 1934 approximately the same.

In 1934, 14,079 tons of aluminum were exported, compared with 15,178 tons in 1933 and 13,597 tons in 1932.

Sweden.—Sweden imported 1,527 tons of aluminum in 1933 and 1,363 tons in 1932. In 1934 an aluminum-reduction plant was built and made a small initial production. With a capacity of 1,800 tons it is expected to supply all Swedish requirements. The new company, called the Aluminiumkompaniet, has its plant at Mansbo, in the Province of Dalarna and is a subsidiary of the Norske Aluminium Co.

Switzerland.—Swiss production of aluminum in 1934 was 8,100 metric tons compared with 7,500 tons in 1933 and 8,500 tons in 1932. The industry is based upon imported alumina derived chiefly from France, which permits utilization of hydroelectric power of the Alps.

The principal Swiss company is L'Aluminium Industrie, which has one of its plants at Neuhausen and often is referred to as the Neuhausen concern. Its interests are widespread, extending into Austria, Germany, and Italy.

U. S. S. R. (*Russia*).—Russian production of 4,400 metric tons of aluminum in 1933 and 14,400 tons in 1934 has been reported officially. Apparently little, if any, aluminum was produced in 1932. Of the total for 1933, 2,882 tons are attributed to the Kirov Aluminum Combinat, the plant of which is on the Volkhov River, Leningrad district. In 1934 it produced 5,832 tons. The capacity of this plant is being increased to 8,000 tons.

Presumably the balance of production—about 1,500 tons in 1933 and 8,600 tons in 1934—was made by the Dnieper plant.

As neither plant has attained its planned capacity an increase of production to 25,000 tons is promised for 1935.

The project for a plant in the Urals on the Iset River near Kamensk is said to be based on two deposits containing 11,000,000 tons in all of bauxite averaging 54 percent alumina and 5 percent silica. The alumina plant will use the Berger (alkali) process. A capacity of 25,000 tons is planned. Judged by available reports and verbal descriptions this project appears substantial and has great promise.

More experimental, but of interest, is a project for utilizing a vast tonnage of nepheline syenite exposed over several thousand kilometers in the Kola Peninsula, Kandalaksha district, Karelia. Work is reported to have begun on a plant at Sosonez on the Murman railroad, where 60,000 kilowatts of water power are said to be available. Production of potash and phosphoric acid as well as aluminum is contemplated in 1938, but such projects necessarily imply scientific and technologic exploration for which the time requirement cannot be forecast accurately.

Russian imports of aluminum were 10,603 metric tons in 1932 and 10,570 tons in 1933. For the first 8 months of 1934, 5,100 tons were reported.

United Kingdom.—British production of aluminum is estimated at 12,500 metric tons in 1934 and was 10,973 tons in 1933, 10,161 tons in 1932, and 14,300 tons in 1931. Most of this was produced from French bauxite. The only bauxite deposits of the United Kingdom are small ones in Ireland, at Larne Harbor, County Antrim, near Belfast; the annual output formerly averaged about 3,000 tons but recently has been less.

The United Kingdom has recently imported large quantities of aluminum from Canada—11,400 tons in 1933 and 13,200 tons in 1934.

In 1934 the Irish Free State placed a 50-percent tariff on manufactures of aluminum. Plans were announced for establishing a factory to manufacture aluminum at Nenagh in the Midlands by the newly incorporated Irish Aluminum Co.

The scheme of damming the Scottish locks to create electrical energy for production of aluminum is nearing completion. Ultimately it will result in production of 130,000 horsepower, operating on a continuous basis. So far the cost exceeds £5,000,000.

In June the much publicized "Grid" system, by which electrical power is distributed throughout England, was completed. Large amounts of aluminum cable were used in its construction.

The British Aluminium Co., Ltd., the chief producer, has two reduction works, both in Scotland. The North British Aluminium Co., Ltd., also has a plant in Scotland. A fourth plant is that of Aluminium Corporation, Ltd., in Wales.

Yugoslavia.—In Dalmatia, Yugoslavia has very large reserves of bauxite, the best of which is found on the islands off the coast. This is said to contain 50 to 55 percent alumina and only about 2 percent silica. In 1933, 80,855 metric tons of bauxite were produced, compared with 67,086 tons in 1932. Most of this production is exported to Germany.

ASIA

India.—Extensive deposits of bauxite in India, which have received much consideration by the Indian Geological Survey, include reserves in the State of Kilhapur reported to contain 15 million tons. A charter has been granted by the State to the Kilhapur Hydroelectric & Aluminum Co. for exploitation of these deposits and reduction of aluminum.

Japan.—Lack of bauxite deposits of its own has made Japan dependent upon imports for its supply of aluminum. Imports of 12,000 tons in 1929 had declined to 2,500 tons in 1931, but they totaled 6,473 tons in 1933 and 9,600 tons in 1934, 4,409 tons of which were scrap.

Consideration was given various projects for improving the strategic position of Japan in this respect, including one for treating shales in Manchuria and others for developing bauxite deposits in the East Indies. The latter has resulted in what appears to be a serious enterprise. A contract for supplying 24,000 tons a year from deposits in the Netherland East Indies by the Nederlands-Indische Bauxiet Exploitatie Maatschappij was reported in May 1934. The Japan Aluminum Reduction Co., a 300-million-yen organization whose shares will be owned by the four large companies producing copper—Mitsui, Mitsubishi, Furukawa, and Sumitomo—will establish aluminum reduction works at Takao, Formosa. Power from the Taiwan Electric Power Co. is available there. Much of the plant equipment is said to have been ordered in Germany. Production capacity will be 6,000 metric tons of aluminum a year.

AUSTRALIA

Bauxite occurs in Australia, but only small production has been made, chiefly from Victoria.

CONCLUSION

Evaluation of the present status of aluminum and the outlook for its future are made difficult by changes in many factors by which both are affected.

Wide-spread desire for national self-sufficiency with respect to aluminum production is one such factor. Russia's astonishing endeavors to establish an enormous aluminum production industry have been followed by less spectacular attempts of other countries (Japan, Sweden, Hungary, and India) to supply at least their own needs by domestic production. The Irish Free State is endeavoring to establish aluminum manufactures. In the Netherlands complaint has arisen that production of aluminum from Surinam bauxite is monopolized by American companies. Germany, though poor in bauxite deposits, is expanding its capacity for aluminum production rapidly. The natural conclusion would be that with present consumption far below world capacity for production established production would meet severe competition.

A compensating factor is the recent wide-spread extension of aluminum utilization in many new directions, including those implied by light aluminum alloys of strength comparable to that of steel. Many of these new uses require large tonnage. It is increasingly evident, for example, that transportation by land, sea, and air will provide expanding outlets for aluminum.

There are also strong indications of a tendency to decrease the price of aluminum, as indicated by a reduction in the price used as a basis for internal settlements within the cartel. Lower price may be expected, in turn, to strengthen the competitive position of aluminum, increase its consumption, and, possibly, reduce its cost of production through fuller utilization of plant capacity. On the whole, the impression seems justified that aluminum is a metal whose status is in course of important readjustments.

The discovery of new processes that might lower the cost of aluminum production substantially is always a possibility. Of interest in this respect is the announcement by the Bohm Aluminum & Brass Corporation of proposed production of aluminum and potash from deposits of alunite in Utah. Preliminary work on the process already is being followed by construction of a pilot plant.

Under the National Industrial Recovery Administration a code applying to secondary aluminum industries became effective in February 1934. Another code for other aluminum industries became effective in July, and subsequently was extended to June 16, 1935. It provided for a code authority of 11 members elected from various branches of the industry, minimum wage rates, a 40-hour week, and provisions regarding the price of aluminum sold to controlled or independent consumers.

4744—35——29

MERCURY

By J. W. FURNESS AND H. M. MEYER

SUMMARY OUTLINE

The history of metal mining in the United States indicates clearly that interest in this industry thrives during times of depression. This may be attributed not only to the necessity for miners to make a living but to the thought that there is always a chance of striking it rich. Mercury mining is no exception to this trend.

According to the producers' association, during 1934 the domestic price did not enable the industry to make a substantial profit; notwithstanding, the domestic production of mercury was 15,445 flasks compared with 9,669 flasks produced in 1933. There were 93 mines reporting production in 1934, whereas there were 75 in 1933. The domestic market for mercury at the opening of 1934 was very favorable, in that producers' stocks were low. This condition did not hold with regard to foreign supplies, as the sales agency for Spanish and Italian mercury had large stocks on hand at the close of 1933.

The agreement between the London agency and sales organization, as well as the International Quicksilver Cartel, has been prolonged for 2 years, despite the cartel's original intention of entrusting its representation to other hands. Prices are fixed by the cartel, and sales must be made direct to consumers, unless special authorization has been obtained to deal with merchants or outsiders. The cartel has strengthened its position, and apparently its most immediate objective is to increase the price gradually without disturbing the market.

Mercury is recovered in the United States from a number of mines scattered over a large area; the metal lends itself to treatment in small retorts that can be erected at relatively little cost, therefore virtually every mine has its own refinery. Many retorts are built, produce a few flasks of metal, and are abandoned because small reserves in the mine are exhausted, the cost of extracting the mercury is high, or some other difficulty interferes. Consequently the extraction of mercury from ores, its shipment, and handling have been highly individualized. Many small operators in the past have been careless in cleaning containers and had insufficient knowledge regarding the proper material for sealing the flasks. These conditions have been responsible in a large measure for the fact that some domestic mercury has not been as pure as it should be and that as a result some consumers of mercury prefer the foreign product.

Graphite free from oil is reported to be the proper compound for sealing mercury containers. Graphite does not amalgamate with mercury and can be removed from the mercury by straining.

In 1925 the average tenor of the recovered mercury in the domestic ores treated was 0.50 percent or 10 pounds per ton of crude ore, the average price was $83.13 New York, production was 9,053 flasks, and the imports for consumption were 20,580 flasks. In 1934 the average tenor of domestic ores was 0.41 percent, the average price was $73.87 New York, the production was 15,445 flasks, and the imports were 10,192 flasks.

To provide a more nearly comparable basis for comparing mercury prices from year to year an "index price" for mercury has been calculated by dividing the New York quoted price by the Bureau of

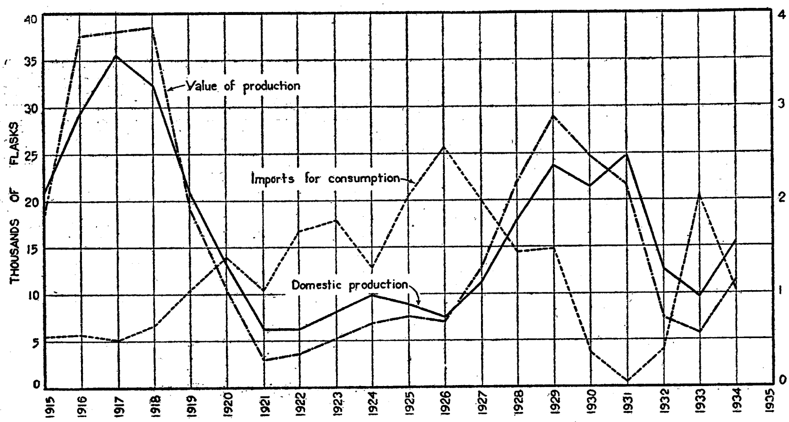

FIGURE 23.—Trends in domestic production, value, and imports of mercury, 1915–34.

Labor Statistics wholesale price index for all commodities. This index price was $56.06 in 1925 and $68.84 in 1934; the advance may account for the increase in domestic production and the decrease in imports in 1934.

Salient statistics of the mercury industry in the United States, 1931–34

[Flasks of 76 pounds]

	1931	1932	1933	1934
Production flasks	24,947	12,622	[1] 9,669	15,445
Number of producing mines	77	95	[1] 75	93
Average price per flask:				
New York	$87.35	$57.93	$59.23	$73.87
London	$89.76	$48.24	$41.64	$56.15
Imports for consumption:				
Pounds	41,733	295,348	1,543,935	774,564
Equivalent flasks	549	3,886	20,315	10,192
Apparent supply flasks	20,512	16,294	[1] 29,700	25,400
From domestic mines percent	97	76	[1] 32	60
Stocks in warehouses (bonded) at end of year flasks	88	[2] 3,840	5,370	4,346

[1] Revised figures.
[2] Probably includes about 3,550 flasks imported late in the year on 1 large contract.

Since 1883 there has been a duty on the imports of mercury. The following table gives the various rates:

Act of—	Paragraph	Tariff classification or description	Rate of duty	Act of—	Paragraph	Tariff classification or description	Rate of duty
1883	211	Quicksilver	10 percent ad valorem.	1909	189	Quicksilver	7 cents per pound.
1890	207	do	10 cents per pound.	1913	159	do	10 percent ad valorem.
1894	170½	do	7 cents per pound.	1922	386	do	25 cents per pound.
1897	189	do	Do.	1930	386	do	Do.

The present duty is $19 per flask of 76 pounds. The following table indicates the differential in price between London and New York from 1922 to 1934, as well as the mercury index price. It may be noted that until 1922 the rates of duty ranged from 10 percent ad valorem to 7 cents per pound. In 1922 it became 25 cents per pound. The Tariff Act of 1922 became effective September 22, and as the act did not cover the calendar year the differential in price for 1922, as given in the table, should not be compared with the years following.

In 1927 the mines administrations of Italy and Spain came to an understanding on the marketing of mercury. In 1928 a common sales agency was appointed by the producers and the Government of Italy with the producers and the Government of Spain. Thus the world price was regulated by the control of approximately 80 percent of world production.

Attention is called to the fact that from 1927 to 1930 inclusive the price of mercury was maintained at a very much higher figure than during peace times in the past. The advance in price was due to the policy of the cartel to establish empirically as high a price as was feasible without curtailing consumption. The high price of 1929, as well as that for the 2 years before, brought out an increased production in the United States which, together with the worldwide depression, caused a steady decline in the domestic price. In 1931, owing to excess production due in part to business conditions, the United States began to export material quantities of mercury; in consequence, the world price was depressed, and the differential between London and New York was to the advantage of the domestic exporter, being $2.41 above the domestic price. The full effect of this condition became apparent in 1932 when the world price was only half as large as it was in 1930. In 1933 when exports were estimated to have been relatively negligible the differential between London and New York rose and has remained more or less constant.

Average yearly prices of mercury at New York and London, 1922–34

Year	New York		London [3]	Excess of New York quoted price over London price
	Index [1]	Quoted [2]		
1922 [4]	$42.56	$58.95	$51.27	$7.68
1923 [4]	46.15	66.50	46.83	19.67
1924 [4]	49.65	69.76	52.93	16.83
1925 [4]	56.06	83.13	66.90	16.23
1926 [4]	64.13	91.90	76.15	15.75
1927	86.44	118.16	104.01	14.15
1928	89.18	123.51	108.54	14.97
1929	89.49	122.15	108.11	14.04
1930	92.90	115.01	105.91	9.10
1931	83.51	87.35	89.76	[5] 2.41
1932	62.42	57.93	48.24	9.69
1933	62.74	59.23	41.64	17.59
1934	68.84	73.87	56.15	17.72

[1] The mercury index price has been calculated for each year by dividing the New York quoted price of mercury by the Bureau of Labor Statistics wholesale price index for all commodities (1913=100).
[2] Engineering and Mining Journal, New York.
[3] Mining Journal (London) prices in terms of pounds sterling converted to American money by using average rates of exchange recorded by the Federal Reserve Board.
[4] Price quoted on 75-pound flask prior to 1927.
[5] London excess.

Average monthly prices of mercury at New York and London and excess of New York price over London price, 1932–34

Month	1932			1933			1934		
	New York [1]	London [2]	Excess of New York over London	New York [1]	London [2]	Excess of New York over London	New York [1]	London [2]	Excess of New York over London
January	$64.90	$62.96	$1.94	$48.50	$36.34	$12.16	$67.54	$48.45	$19.09
February	66.30	62.43	3.87	48.61	36.26	12.35	72.01	53.14	18.87
March	72.54	68.56	3.98	52.68	34.54	18.14	75.47	54.76	20.71
April	72.13	66.27	5.86	54.58	35.57	19.01	75.93	55.40	20.53
May	66.38	56.73	9.65	56.50	37.85	18.65	75.58	55.21	20.37
June	59.48	48.77	10.71	60.04	40.32	19.72	75.00	57.80	17.20
July	53.58	39.67	13.91	62.90	44.81	18.09	75.00	57.19	17.81
August	47.44	34.57	12.87	63.50	41.57	21.93	75.00	58.12	16.88
September	47.50	35.04	12.46	64.58	43.03	21.55	74.56	57.93	16.63
October	47.60	35.15	12.45	66.50	45.38	21.12	74.00	58.67	15.33
November	48.75	35.41	13.34	66.00	50.70	15.30	73.28	58.62	14.66
December	48.50	36.26	12.24	66.33	49.79	16.54	73.00	58.11	14.89
Average	57.93	48.24	9.69	59.23	41.64	17.59	73.87	56.15	17.72

[1] Engineering and Mining Journal, New York.
[2] Mining Journal (London) prices in terms of pounds sterling converted to American money by using average rates of exchange recorded by the Federal Reserve Board.

Broadly, as imports increase the domestic price represents a higher differential over world price. During 1931, when 4,984 flasks were exported, the domestic industry failed to enjoy any advantage from the tariff and actually was forced to sell its product below the London price.

The inference to be drawn from the foregoing table is that when a protected industry disposes of its surplus in the international market the latter is upset, the world price is influenced, and price is in turn affected in the protected country.

Consumption and uses.—The following table shows the supply of mercury in the United States from 1924 to 1934:

Supply of mercury in the United States, 1924–34

[Flasks of 76 pounds]

Year	Production (flasks)	Imports for consumption (flasks)	Exports (flasks)	Apparent supply		
				Total (flasks)	From domestic mines (percent)	Imported (percent)
1924	9,952	12,996	205	22,743	42.9	57.1
1925	9,053	20,580	201	29,432	30.1	69.9
1926	7,541	25,634	114	33,061	22.5	77.5
1927	11,128	19,941	(1)	[2] 30,900	35.5	64.5
1928	17,870	14,562	(1)	[2] 32,300	54.9	45.1
1929	23,682	14,917	(1)	[2] 38,500	61.3	38.7
1930	21,553	3,725	(1)	[2] 25,200	85.2	14.8
1931	24,947	549	[3] 4,984	20,512	97.3	2.7
1932	12,622	3,886	[3] 214	16,294	76.2	23.8
1933	[4] 9,669	20,315	(1)	[2] [4] 29,700	[4] 31.6	[4] 68.4
1934	15,445	10,192	(1)	[2] 25,400	59.9	40.1

[1] Not separately classified for 1927–30 and 1933.
[2] Estimated by Bureau of Mines.
[3] From a special compilation by the customs statistics section, Bureau of Foreign and Domestic Commerce.
[4] Revised figures.

The part played by mercury in our industrial world differs basically in many respects from that of other metals. The consumption of most minerals depends largely upon the convenience of price rather than upon chemical or physical characteristics. At price, one metal may be substituted for another for most uses. The demands for mercury are based upon physical and chemical properties to possibly a greater extent than any other of our metals, therefore wide fluctuations in price do not ordinarily greatly alter present habits of consumption.

Before 1900 there were three major uses of mercury: Amalgamation of gold and silver; in the manufacture of vermilion red (a pigment); and in fulminate used as a detonator for high explosives. Minor uses were for medical purposes and for scientific apparatus. With the exhaustion of our free gold and silver ores comparatively little mercury now is used in amalgamation. Owing to the price of vermilion red, mercury pigments virtually have been eliminated, and such substitutes as antimony sulphuret, red lead, and hematite have captured the market held previously by mercury.

At varying prices, fulminates, insecticides, and the quartz mercury vapor light probably are the largest consuming uses.

Mercury vapor is employed for such industrial purposes as distillation of betanaphthol and sulphonation of naphthalene. The Sun Oil Co. uses it for distillation of lubricating oils.[1]

A new light source developed in the laboratories of the Westinghouse Electric & Manufacturing Co. and known as the high-pressure mercury lamp, is expected to exert considerable influence on artificial lighting practice of the future. The lamp has no filament, the light being produced by a mercury arc stream of great brilliancy. The development of this lamp is the beginning of a definite forward step in the use of metallic-vapor light sources.[2]

[1] Chemical Industries, vol. 35, no. 3, September 1934, p. 251.
[2] Engineering and Mining Journal, vol. 135, no. 7, July 1934, p. 332.

REVIEW BY STATES

The greater activity at mercury mines in the United States in 1934 is attested by the increase of 60 percent in production and the gain in number of productive mines from 75 in 1933 to 93 in 1934. It is interesting to note that, in general, the increased production did not result from the larger number of active properties. Many of the mines that produced mercury in both years accounted for only a few flasks, and 14 of the 15 leading producers were responsible for 86 percent of the increased output. Only one of the important mines in 1934, the Oceanic, was idle in 1933. In 1934, 78 mines contributed less than 2,000 flasks to the total production, an average of a little less than 26 flasks per mine. California's output doubled in 1934, although the number of mines was the same. Production in Oregon in 1934 was 158 percent larger than in 1933, and the number of producing mines increased from 5 to 11.

The work that has been done in the Terlingua field of Texas apparently would indicate that at price there is a considerable reserve of mercury in this area. It has been reported that the difficulties encountered due to code regulations in reference to labor were responsible for the closing of the Chisos mine, which curtailed the production of this area considerably.[3]

The principal mercury-producing mines in 1934 were: Parker property, Pike County, Ark.; Great Western, Mirabel, and Sulphur Bank mines, Lake County; Aetna and Oat Hill mines, Napa County; New Idria mine, San Benito County; Klau and Oceanic mines, San Luis Obispo County, and Cloverdale mine, Sonoma County, Calif.; Blackbutte mine, Lane County, and Bretz mine, Malheur County, Oreg.; Big Bend, Chisos, and Rainbow mines, Brewster County, Tex. In addition to the increased activity at productive mines there was a larger amount of exploratory and development work in 1934 at properties that did not produce any metal in that year.

Mercury produced in the United States, 1931–34

	Producing mines	Flasks of 76 pounds	Value [1]
1931:			
California	45	13,448	$1,174,696
Nevada	16	2,217	193,657
Oregon	5	5,011	437,716
Washington	4	560	48,917
Texas, Arizona, Arkansas, and Alaska	7	3,711	324,159
	77	24,947	2,179,145
1932:			
California	63	5,172	299,588
Nevada	15	474	27,456
Oregon	7	2,523	146,145
Washington	3	407	23,575
Texas, Arizona, Arkansas, and Alaska	7	4,046	234,365
	95	12,622	731,129

	Producing mines	Flasks of 76 pounds	Value [1]
1933:			
California	[2] 49	[2] 3,930	[2] $232,762
Nevada	12	387	22,921
Oregon	5	1,342	79,483
Texas, Arkansas, Washington, and Utah	9	4,010	237,500
	[2] 75	[2] 9,669	[2] 572,666
1934:			
Arkansas	5	488	36,046
California	49	7,808	576,738
Nevada	18	300	22,160
Oregon	11	3,460	255,573
Washington	5	330	24,375
Texas and Arizona	5	3,059	225,953
	93	15,445	1,140,845

[1] Value calculated at average price for quicksilver at New York.
[2] Revised figures.

[3] Metal and Mineral Markets, vol. 5, no. 39, Sept. 27, 1934, p. 5.

ARIZONA

Mercury was produced by Tyree Trobaugh in 1934 from retorts at the property known as the Mercury Mines of America, the first production from this mine since 1929.

ARKANSAS

During the year the Pike County deposits were examined by John C. Reed, J. M. Hansell, and F. G. Wells of the United States Geological Survey. The following statement prepared by them is published by permission of the Director of the Survey:

Cinnabar from southwestern Arkansas was first identified in June 1931 by W. M. Weigel [4] in a specimen sent to him by Walter F. Hintze, of Murfreesboro.

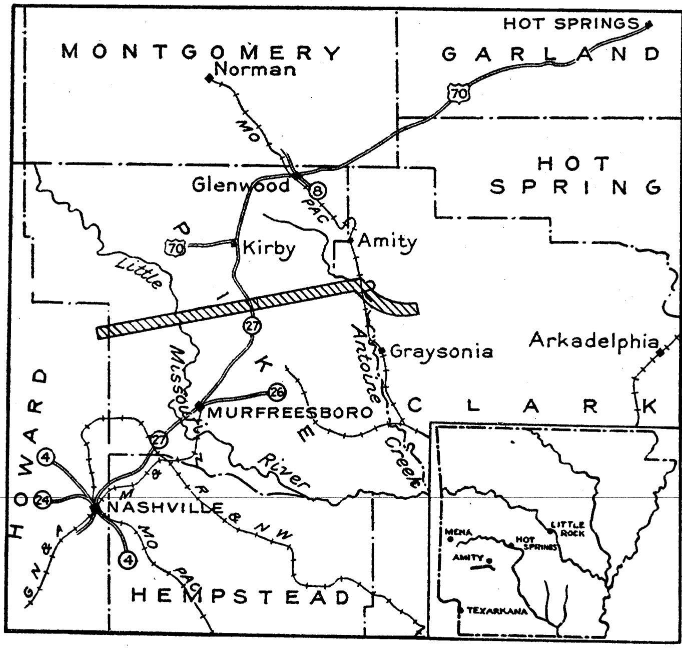

FIGURE 24.—Location and extent of the Arkansas mercury district.

By January 1932 prospecting had disclosed a mineralized belt about 25 miles long and in most places less than a mile wide, trending in an east-northeast direction from Howard County, on the west, across central Pike County and into Clark County, on the east (fig. 24). More recent discoveries of cinnabar in Clark County have increased the known linear extent of the district to more than 30 miles. This is the only new mercury district that has been discovered in the United States for many years.

Although all the figures are not available, it is estimated that up to the present time more than 2,000 flasks of mercury have come from the district. The two original discovery areas were near the Little Missouri River and near Antoine Creek, and, as the early activity centered there, most of the production has come from those places.

[4] Weigel, W. M., New Quicksilver Discoveries: Eng. and Min. Jour., vol. 132, pp. 495-497, 1931.

In 1932 the Arkansas State Geological Survey published a circular [5] that describes the geology of the district and the occurrences of cinnabar then known. This article [6] brings the description of the district up to the spring of 1935.

The district in 1934 was still too new to have been extensively developed, and the work done so far consists largely of shallow trenches and small prospect pits. The three mines of the Southwestern Quicksilver Co., however, have been developed to depths of 225, 29, and 187 feet, and at the property of the Arkansas Quicksilver Co., also, development has been relatively extensive.

The development work on all the properties, except those prospects where practically no work has been done, is summarized below. The properties are given in order of geographic occurrence from the east end of the district to the west (fig. 25).

Arkansas Quicksilver Co.—The principal workings of the Arkansas Quicksilver Co., are on the hill in the SW¼ sec. 28 and the NW¼ sec. 33, T. 6 S., R. 23 W. Five adits, aggregating about 850 feet, were driven and several test pits were dug in 1931 and 1932. Work was discontinued in November 1932 but was resumed in August 1933, and continued until May 1934. Most of the ore has come from a small glory hole, from the bottom of which a shaft has been sunk to a depth of about 50 feet below the surface. It is estimated that about 2,500 tons of rock has been mined from the glory hole and that about 11,000 pounds of mercury has been recovered from it.

All the mercury from this property has been the product of a 2-tube Gould retort at Graysonia, about 8 miles south of the property. The ore was trucked to the retort. The retort was first put into operation in November 1931, and has been in use intermittently since then.

Small openings have also been dug on outcrops containing considerable cinnabar on the property of this company in secs. 29 and 32, T. 6 S., R. 23 W.

According to reports the properties of the Arkansas Quicksilver Co. were leased by the Midcontinent Quicksilver Corporation in March 1935, and the lessees are now actively prospecting, with the idea of installing a plant when a sufficient supply of ore seems assured.

Deering prospect.—In 1932 the Exploration Co. opened a trench 30 feet long, 12 feet wide, and 3 feet deep on the property of Warner Deering in sec. 19, T. 6 S., R. 23 W. In January 1934 the trench was widened 3 feet and deepened to 15 feet at its west end by Mr. Schwartzberg. This property, as well as some south of the property of the Arkansas Quicksilver Co., is now leased to the Amity Quicksilver Co., and since they began operations in May 1934 they have been sinking a shaft and putting mining equipment on the property. There has been no production to date.

Palmer prospect.—Several trenches and test pits were dug by T. P. Palmer in sec. 26, T. 6 S., R. 24 W., in the spring of 1934.

Marino prospect.—In 1932 the C. Mining Corporation opened two trenches, each about 20 feet long and 4 to 6 feet deep, in sec. 27, T. 6 S., R. 24 W., on the Marino property. There are several smaller pits in the vicinity.

The company leased the Southwestern Quicksilver Co. plant in the spring of 1935 and will furnace test runs of ore from different workings.

C. Mining Corporation.—A prospect pit and a shaft were opened on the property of the C. Mining Corporation in sec. 32, T. 6 S., R. 24 W. in 1932. The shaft is now full of water, but it is reported to be 60 feet deep. The company erected a reduction works intended for use as a custom plant on highway 27, about 1 mile south of Kirby, but the plant was operated only for a period of a few weeks in 1932.

Southern Craft Paper Co.—Nine prospect trenches were dug on the property of the Southern Craft Paper Co. in secs. 32 and 33, T. 6 S., R. 24 W., in the spring of 1935. Some high-grade ore was removed, but no information could be obtained as to the tons of ore retorted or the mercury recovered.

Arkansas Cinnabar Mining Co.—About a dozen pits and trenches were opened in 1932 by the Arkansas Cinnabar Mining Co. on property belonging to Joe Cox in sec. 2, T. 7 S., R. 25 W.

Joe Cox prospect.—Two shafts about 30 feet deep were sunk and a trench 20 feet long and several prospect pits were dug on land of Joe Cox in sec. 3, T. 7 S., R. 25 W., in 1932, by D. O. Roller, C. H. Lumin, and I. J. Brooks. A 1-tube retort was constructed. No work has been done since 1932.

[5] Branner, G. C., Cinnabar in Southwestern Arkansas: Arkansas Geological Survey Inf. Cir. 2, 1932.

[6] Most of the information on development herein contained is taken directly from an article by J. M. Hansell entitled "Mining Development of the Arkansas Quicksilver District to July 1, 1934", which was written at the request of the State geologist of Arkansas while Mr. Hansell was employed by the U.S. Geological Survey in the district. This article was published in August 1934 as a supplement to Information Circular 2 of the Arkansas State Geological Survey. The information on development is brought up to date by F. G. Wells, currently in charge of a Geological Survey field party in the district.

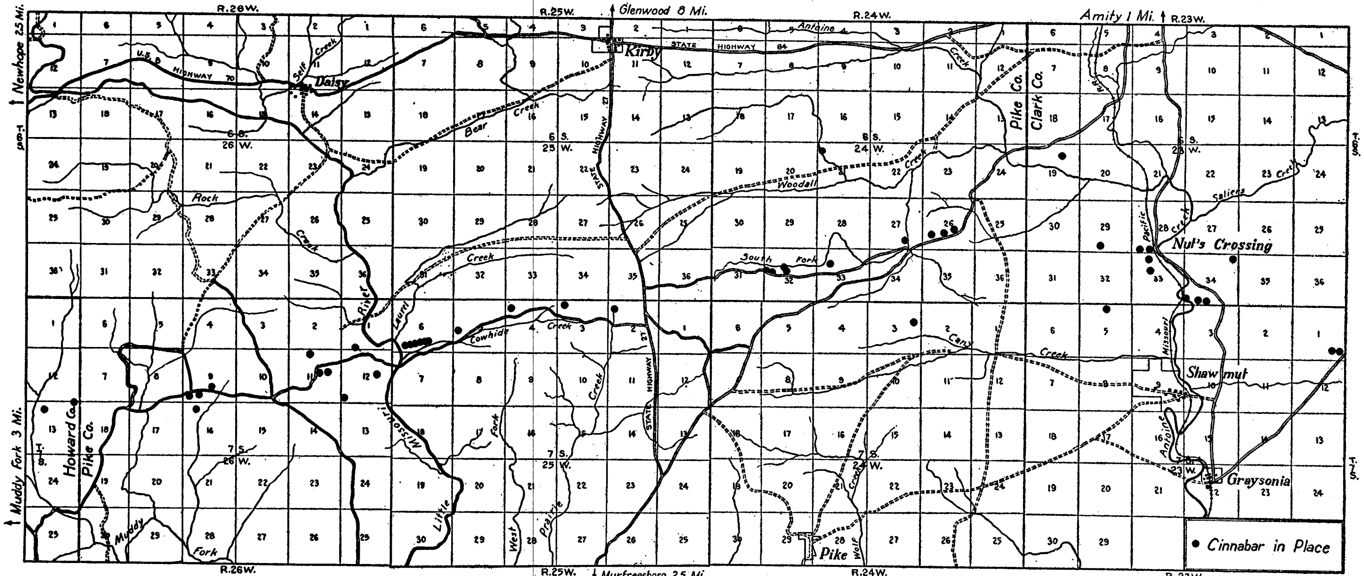

FIGURE 25.—Location of mercury deposits in Arkansas.

Funderburk prospect.—At the Funderburk prospect, in the NW¼NW¼ sec. 3, T. 7 S., R. 25 W., the development consists of a trench 75 feet long, 10 feet wide, and about 20 feet deep at its north end. This was opened by C. I. Barfield in 1932. A small 1-tube retort was built, but is now dismantled.

Old Argentine mine.—The Old Argentine mine, in sec. 4, T. 7 S., R. 25 W., includes a 30-foot shaft sunk late in 1932 and early in 1933 by C. Caponetto and several shallow trenches and test pits.

Lula Bell prospect.—About 20 small pits and trenches have been dug at the Lula Bell prospect, in secs. 5 and 6, T. 7 S., R. 25 W., by M. G. Sherwood, under the direction of B. E. Isbell. Prospecting is in progress and, according to reports, about 13 flasks of mercury were produced in 1934–35. It is reported that the mercury produced in 1934 was obtained from ore treated in the retort of Otto Yenglin, and that in 1935 from ore run through the plant of the Southwestern Quicksilver Co.

Otto Yenglin prospect.—Otto Yenglin began prospecting by test pits in sec. 6, T. 7 S., R. 25 W., in May 1934 and has continued to the present time. One pit has reached a depth of 20 feet and another 10 feet. There are several other shallower pits on the property. A small retort has been installed.

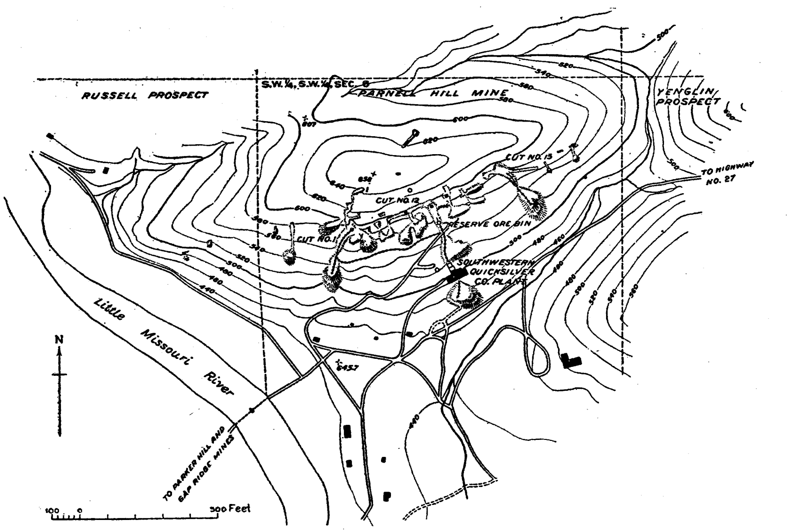

FIGURE 26.—Plan of the Parnell Hill mine of the Southwestern Quicksilver Co., Murfreesboro, Ark.

Southwestern Quicksilver Co.—The principal producer in the district has been the Southwestern Quicksilver Co. Prospecting on this company's property began in August 1931 under the direction of Leo Yount. The most intensive work was done on Parnell Hill, in sec. 6, T. 7 S., R. 25 W.; on Parker Hill, the original discovery site of the district, in sec. 1, T. 7 S., R. 26 W.; and on Gap Ridge, in sec. 11, T. 7 S., R. 26 W. In April 1932 a Gould rotary furnace with a capacity of about 12 tons a day was installed on Parnell Hill, and this furnace has been operated a considerable proportion of the time since then.

During the prospecting the mineralized rock was sorted and the waste discarded in the openings as the work progressed. In the shaft mining all the rock is hoisted, dumped into bins, and then sorted by hand to a concentrate averaging about 20 pounds of metallic mercury to the ton. The proportion of waste rock to concentrate of this tenor varies, but the average from combined prospecting and shaft mining on Parker Hill and Gap Ridge is estimated to be 6 tons of rock to 1 ton of ore carrying 20 pounds of mercury to the ton.[7] On Parnell Hill it was necessary only to tram the ore to the plant for crushing and furnacing, but during 1934, when all the production came from the Parker Hill and Gap Ridge mines, the sorted ore had to be trucked to the plant on Parnell Hill, by way of a company-built ferry across the Little Missouri River.

In spite of the relatively good market and high price of the metal during 1934 as compared with the two preceding years, the company suspended all

[7] Yount, Leo, personal communication to J. M. Hansell.

operations in September 1934, because of higher labor costs and the lack of adequate pumps to handle the increased flow of water in the Parker Hill and Gap Ridge mines.

The main openings of the Parnell Hill mine are shown in figure 26. Considerable ore was obtained from cut 1, and a shaft was sunk to a depth of 14 feet below the bottom of the opencut, or about 65 feet below the surface. In cut 12 cinnabar was obtained from an ore shoot pitching at a steep angle to the east. This shoot was followed by an incline to a depth of 87 feet below the bottom of the cut, or 122 feet from the surface outcrop. Mineralized rock that was found for 140 feet west from cut 12 ended at a horizontal fracture about 15 feet below the surface. East of cut 12 a small rich ore shoot was followed to a depth of 187 feet. There are many other small prospect pits on Parnell Hill.

Since the suspension of company operations in September 1934, about 6 men have worked a few favorable localities in cut 1 and between cuts 12 and 1, on a share basis. The ore has been furnaced in the company's plant.

The original discovery of mercury in the district was at the opening on the southwest side of Parker Hill (fig. 27), and in addition to cinnabar much native mercury has been found there. The best ore has been found farther east on the southeast side of the hill, where the principal mine opening is located. A shaft was sunk to a depth of 75 feet and a stope was opened 27 feet east from the shaft

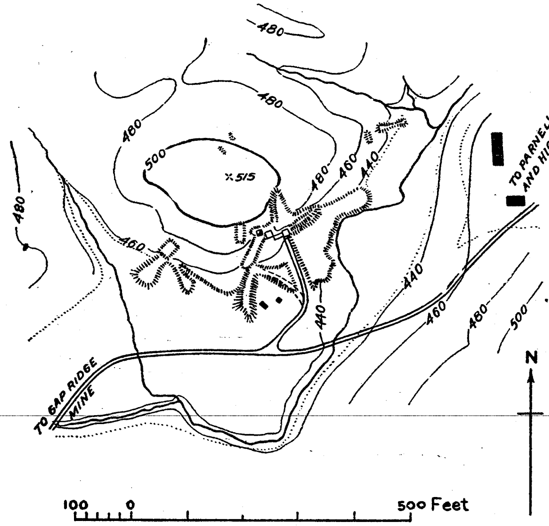

FIGURE 27.—Plan of the Parker Hill mine of the Southwestern Quicksilver Co., Murfreesboro, Ark.

for the full depth. Difficulty in retaining the shale hanging wall caused the shaft to be abandoned, although good ore was present in the bottom. A second shaft was sunk along the east side of the stope already opened, to a depth of 129 feet below the surface outcrop. At 113 feet a drift was run west 30 feet, and good ore, 6 to 8 feet wide, was exposed all the way. A pocket containing native mercury was found in this drift. The bottom of the shaft encountered a flow of water estimated at more than 300 gallons an hour. It is believed that this is ground water contained in adjacent sandstone beds, under head because of the depth of the shaft, 70 feet below ground-water level, which is approximately river level, and sealed off from the shaft by clay and shale until this depth was reached. Until this flow was encountered very little pumping was necessary to keep the shaft dry.

The principal opening at the Gap Ridge mine (fig. 28) is an open stope 225 feet deep, 6 to 8 feet wide, and about 75 feet long. Just before the mine was shut down a flow of water estimated at about 500 gallons an hour was encountered. The mine has reached a depth of about 125 feet below ground-water level. The ore is found in several closely spaced shoots that pitch about 70° W. It varies in tenor both laterally and vertically but is generally of good grade. In addition to cinnabar it carries some stibnite and pyrite.

Russell prospect.—Several trenches and pits have been dug on the Russell property, on the west end of Parnell Hill. (See fig. 26.) Work in 1933 and part of 1934 was under the direction of H. E. Smith. A 1-tube retort has been built. Late in 1934 and in 1935 the work was under the direction of R. C. Roahdanz. Mr. Roahdanz reports that about 15 flasks were produced from 102 tons of ore. Operations were discontinued in April 1935.

Arkansas Power & Light Co. prospect.—A trench 40 feet long, 7 feet wide, and from 10 to 25 feet deep was opened late in 1931 and early in 1932 by George Bell and W. F. Hintze on property of the Arkansas Power & Light Co., in sec. 12, T. 7 S., R. 26 W.

J. G. Parker prospect.—A small retort was installed and a test pit about 15 feet deep was dug at the J. G. Parker prospect, in the SE¼ SW¼ sec. 12, T. 7 S., R. 26 W., between May and September 1933.

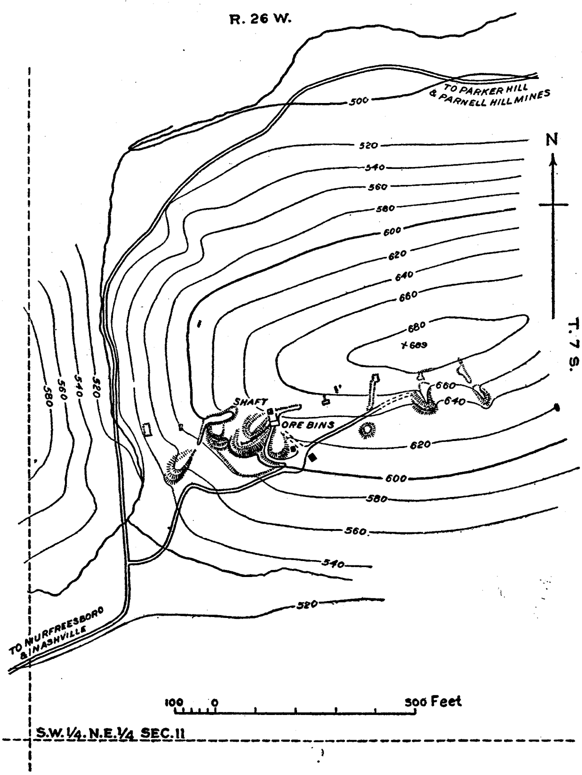

FIGURE 28.—Plan of the Gap Ridge mine of the Southwestern Quicksilver Co., Murfreesboro, Ark.

W. O. Hudgins prospect.—In sec. 9, T. 7 S., R. 26 W., on the property of W. O. Hudgins, prospecting began in September 1933, and a 2-tube retort, with a capacity of 1,200 pounds a day, was built. This retort was replaced in June 1934 by a 24-tube retort. Power is supplied by a steam boiler, and because of scarcity of water during the summer no active work has been done since June 1934. A 30-foot shaft and several shallow test pits have been opened on the property, which has produced about 300 pounds of mercury.

Will Pyle prospect.—In 1932 shallow test pits were dug in secs. 12 and 13, on the Will Pyle prospect, by Z. A. Copeland, and in 1933 these openings were enlarged by Brown & Rison. In 1934 C. E. Holmes and O. E. Schow took over the property, and they have done some further work in the test pits.

S. N. Floyd prospect.—Brown & Rison sank a 35-foot shaft on the S. N. Floyd property, in sec. 12, T. 7 S., R. 27 W., in 1933. A small 1-tube retort was also constructed.

J. B. Floyd prospect.—A trench 85 feet long, 3 feet wide, and with a maximum depth of 25 feet was dug in 1932 at the J. B. Floyd prospect, in sec. 13, T. 7 S., R. 27 W., under the direction of Z. A. Copeland. In 1934 C. E. Holmes and O. E. Schow erected a 2-tube Gould retort preparatory to further development.

Possibilities of the district.—Because the Arkansas mercury district is so new and so slightly developed it is impossible to make an accurate prediction of its possibilities compared to those of other mercury districts. The area is more than 30 miles long, and cinnabar has been observed in place at many localities within it. However, only a few of these occurrences have been prospected even slightly and at less than half a dozen places have more than a few tons of rock been moved. At the Gap Ridge and Parker Hill mines the proportion of waste rock to ore of the tenor of 20 pounds of mercury to a ton has been about 6 to 1. This gives a mercury content of 2.9 pounds to the ton of rock mined. It should be emphasized that this figure includes prospecting as well as mining, and does not include the mercury in the rock discarded as waste. At the property of the Arkansas Quicksilver Co., according to reports, 11,000 pounds of mercury has been recovered from a glory hole from which 2,500 tons has been mined, or a recovery of 4.4 pounds to the ton. Here also the waste dump contains considerable cinnabar.

The surface showings at the localities which have yielded most of the ore so far found were not appreciably better than many other showings within the district as yet untested. The low relief of the region, the scarcity of good outcrops, and the heavy brush cover combine to make surface prospecting difficult. Underground prospecting is hampered by the irregularity of the fracture zones in which the cinnabar is found and by the irregular distribution of ore within these zones.

Geologic indications, which are summarized in Technical Publication 612 of the American Institute of Mining and Metallurgical Engineers, appear to warrant further prospecting and development in favorable areas.

It seems likely that in a time of national emergency, when cost is no object, the Arkansas mercury district could produce a large amount of the metal. Whether or not mercury could be produced at a profit in the district under conditions similar to those of 1934 or early 1935 is not yet known, though it probably could be, except for the relatively high cost of prospecting for ore bodies. Even with this drawback it is entirely possible that some enterprises may prove successful.

CALIFORNIA

The same number of mines were active in California in 1934 as in 1933, but production in 1934 doubled that of the preceding year. Increased production at 9 of the 10 largest producing mines in 1934 accounted for 85 percent of the gain in the total for California, and production from the reopened Oceanic mine, idle in 1933, was enough to more than make up the remainder of the increase. It is obvious therefore that a lower proportion of the production came from small producers in 1934 than in the preceding year. Output in California amounted to 51 percent of the total for the country, whereas in 1933 it was 41 percent of the total.

Colusa County.—The Manzanita mine was in operation in 1934, and mercury was produced in retorts from ore mined during the year and from dumps.

Fresno County.—The Arambide Mining Co. reported spending most of 1934 blocking out ore bodies and building a 40-ton rotary furnace at the Arambide mine 25 miles from South Dos Palos. Some mercury was produced in the new plant. Ben J. Byles produced mercury by retorting ore at the Archer mine.

Kern County.—Some mercury was produced at the Cuddeback mine.

Kings County.—Mercury was produced in a retort at the Fredanna mine in 1934.

Lake County.—Six properties produced mercury in Lake County in 1934; these included the Sulphur Bank and Mirabel mines—2 of the 3 largest producing mines in the State, and among the 7 largest producers in the country. The other producers were the Great Western, an important contributor, Rich Hill, Red Elephant, and Helen mines. Teall Messer reported that after experimenting for 2 years in an attempt to solve the problem of treating high-sulphur ores at the Big Chief mine he has been successful and that a plant is being installed on the adjacent Schwartz-Anderson property (which he leased) below the present workings at Big Chief. A laboratory will be part of the new plant, which, he reported early in 1935, probably would be in operation by April. A new tile-pipe condensing system was reported as being built at the Sulphur Bank mine. Construction of a new furnace at the Red Elephant mine 17 miles from Lower Lake was begun in 1934.

Monterey County.—A small quantity of mercury was produced in a retort at the Patriquin mine in 1934.

Napa County.—Production of mercury was made by seven properties in this county; of these, the Oat Hill and Aetna mines were important producers. The Oat Hill mine was one of the three largest mercury-producing mines in the State. At the Knoxville mine mercury was recovered from cleaning up under old furnaces and condensers.

San Benito County.—New Idria was, as usual, the largest producer in San Benito County. As in 1933 and most of 1932 no mining was done, and production was from dumps and old pits. Other producing properties in the county were the Aurora, Clear Creek, Stayton, Alpine, and Black Hawk. A small furnace was reported being installed at the Clear Creek mine.

San Luis Obispo County.—Ten mines produced in San Luis Obispo County, the Oceanic being the largest. The Oceanic mine, operated by the Anglo American Mining Corporation, was idle throughout 1933 but resumed production in 1934 and was again one of the leading producers of the State and country. A small quantity of mercury was produced in Rossi retorts at the 7 X Ranch mine. Rossi retorts also were used at the Bonanza and Bagby mines for the production of mercury. Various leasers operated the Carson, Capitola, and Santa Monica mines (owned by E. W. Carson) during most of 1934 and produced mercury in Rossi retorts. In August the properties were leased to the Klau Mine, Inc., which completed the installation of a new 3- by 40-foot Gould rotary furnace in December and produced mercury therein during the last 2 weeks of the year. It is reported that the upper levels of the mine are being opened up and developed by the new company. A concentrating plant for the treatment of old dumps was reported as being installed at the Mahoney mine early in 1935.

Santa Clara County.—Mercury was produced from the old dumps at the New Almaden mine in 1934, as in several preceding years.

Sonoma County.—Mercury was produced at the Cloverdale, Skaggs Springs, Sommerset, Esperanza, and four other properties in 1934, double the number active in 1933. The output of the Cloverdale mine was made in a rotary furnace, whereas production at the other properties in the county was from small retorts.

Trinity County.—The Altoona mine was the only productive mercury property in Trinity County in 1934.

NEVADA

The mercury output of Nevada has been declining since the record output of 4,764 flasks in 1929; it amounted to only 300 flasks in 1934. The number of properties that produced in 1934, however, was only 1 less than the number that accounted for the 1929 output—18 compared with 19. The Castle Peak mine 10 miles from Virginia City, Storey County, although operating probably less than 6 months, was the largest producer in the State in 1934. According to press reports, in June the mine shaft was sunk to a depth of 340 feet, 190 feet below the level of the mill adit, and considerable development work was being carried on below stopes that have yielded profitable ore. E. P. Stites operated the Reward mine in Dunlop Canyon east of Mina during part of 1934 and produced a small quantity of mercury in a 5-ton Wyatt furnace. A cloudburst is reported to have done great damage at the mine during the year, washing houses and equipment down the canyon, and Stites abandoned operations there. A 20-ton concentrating plant was erected by lessee on the property of Flower & Logan near Belmont, Nye County. Press reports indicated a rich strike at this mine late in 1934. J. I. Guthrie erected a small furnace and retort at the Goldbanks mine 40 miles from Winnemucca in Pershing County in 1934 and made a small production of metal.

OREGON

Production of mercury in Oregon in 1934 was more than two and one-half times that in 1933, being 3,460 flasks compared with 1,342. The number of mines that contributed to production increased from 5 to 11, but the larger output is explained principally by a higher rate of production at the Bretz and Blackbutte mines, the largest mercury-producing properties in the State and 2 of the 4 largest producers in the country. Oregon was the second largest mercury-producing State in 1934, with an output that constituted 22 percent of the total for the country. The Ashwood district, Jefferson County, produced mercury for the first time in 1934. Considerable exploration and development work were reported at properties that did not produce in 1934.

Clackamas County.—The Oak Grove mine was operated by Geo. Nisbet and D. E. Kiggins in 1934. The ore was taken from surface workings, chiefly from solid calcite veins, and treated in a coarse-ore furnace. Ore from decomposed and clayey veins was concentrated and burned in a smaller furnace.

Crook County.—A. J. Champion produced a small quantity of mercury from the Champion mine in a rotary retort on the property and did custom work in his plant for three nearby properties. Press reports indicated that the 25-ton Nichols Herreshoff furnace at the Maury Mountain mine was sold to the Crystal Mining Syndicate, superseded by Horseheaven Mines, Inc., Jefferson County. The Maury Mountain mine was operated by Eickemeyer Bros. in 1934 and a quantity of mercury recovered in a neighboring retort. Some mercury was recovered at the Maury mine before the furnace was removed.

Douglas County.—A 40-ton Gould rotary furnace was being installed at the Buena Vista mine, Tiller district, by the Umpqua Mining Co.

Jackson County.—A small quantity of mercury was produced in a retort at the Little Jean mine, Meadows Mining district. Wm. P. Chisholm, owner and operator of the Little Jean, reported that on the 100-foot level ore was opened up for half a mile and averaged about 0.5 percent mercury. Development work at the Steamboat mine was continued.

Jefferson County.—The mercury production reported for this county in 1934 is the first on record. The output was from the Horseheaven mine in Ashwood district 43 miles from Madras and was made in a newly installed 25-ton Nichols Herreshoff furnace. The Horseheaven mine ranked third in importance among the mercury-producing properties of the State in 1934.

Lane County.—The Blackbutte mine of the Quicksilver Syndicate was one of the 2 largest producers in the State and one of the 4 largest in the country. In August press reports indicated that the company was handling about 70 tons of ore a day and employing 43 men, 20 in the mine and 15 in the smelter.

Malheur County.—The Opalite mine, which has made a large production of mercury in the past, was idle in 1934. The Bradley Mining Co., however, operated the Bretz mine during the year, treating the ore produced in the 100-ton rotary furnace on its Opalite property. The Bretz mine was one of the 2 largest mercury-producing mines in the State and one of the 4 largest in the country.

TEXAS

In 1934 Clyde P. Ross, of the United States Geological Survey, made a reconnaissance of the mercury resources of Brewster County, Tex.; and it is through the courtesy of the Director of the Survey that the following information is made available to the Bureau of Mines for inclusion in the mercury chapter.

Nearly all known occurrences of mercury in Texas are in two small areas, the Terlingua and Mariscal districts (fig. 29), Brewster County, in the Big Bend of the Rio Grande in the southwestern part of the State. Production from this region, chiefly from the Terlingua district, has maintained Texas generally in second place among mercury-producing States during the last 35 years, exceeded only by California, and occasionally by either Nevada or Oregon or both.

The geology of these districts is outlined briefly in a paper in course of publication by the Texas Bureau of Economic Geology.[8] This paper also contains some data on the history and production of the districts and cites the principal previous publications relative to their geology. Statements in the present report on property ownership are based mainly on a map of the Terlingua district by H. R. Gard, county surveyor, brought up to date by him in June 1934.

The Terlingua district, with the town by that name forming the center, is a rectangular area about 15 miles long in an east-west direction and 5 miles wide. Most of it lies in the southern parts of blocks G12 and G4 of the Texas system of public-land surveys. There are about 30 mines and prospects in the district, but only a few

[8] Ross, C. P., Preliminary Report on the Terlingua Quicksilver District, Brewster County, Tex.: The Geology of Texas, vol. 2, Texas Univ. Bull. 35 (in press April 1935).

of these have yielded much mercury. The town of Terlingua is about 84 miles from the Southern Pacific Railroad at Alpine and somewhat farther from Marathon, the principal shipping point for the district.

The Mariscal district is a small area on Mariscal Mountain and vicinity in the bight of the Big Bend of the Rio Grande in block G3. The only developed mine (now inactive) is close to the crest of Mariscal Mountain. Several prospects lie within a mile to the north, and another small prospect lies about 5 miles to the southeast. The old Mariscal mine is over 50 miles by road from Terlingua but only about 30 miles in a straight line across the south end of the Chisos Mountains. The district may be reached from Marathon, which is well over 100 miles away, although a road from Alpine through Terlingua and Castolon also is available.

FIGURE 29.—Location of the Terlingua and Mariscal mercury deposits, Brewster County, Tex.

TERLINGUA DISTRICT

Western part.—For purposes of description the Terlingua district may be divided into two parts, with the Long Draw (fig. 30) as the boundary between them. The western part contains the original discoveries and the principal mines of the early days but is comparatively quiet now. When mining was begun in the late nineties a settlement known as "Terlingua" (a corruption of "Tres lenguas" or "Las lenguas") grew up close to California Mountain, then the location of the principal development. When the post office was moved to the settement at the Chisos mine in the eastern part of the district about 1910, the name was transferred with it. It should be borne in mind that mentions of "Terlingua" in early accounts refer to the vicinity of California Mountain and not to the settlement now bearing this name.

The principal early development was done by the Marfa & Mariposa Mining Co. in and close to California Mountain in sec. 59, block G12, in the period from 1894 to about 1910. The yield from this work was locally estimated at about 20,000 flasks of mercury. There was a

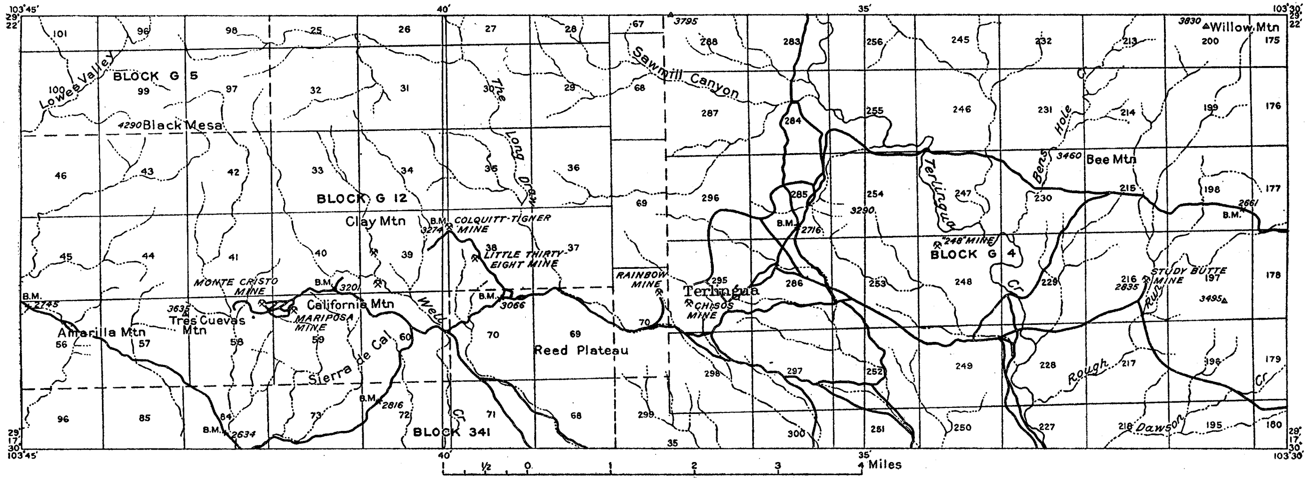

FIGURE 30.—Location of the principal mercury mines in the Terlingua district, Brewster County, Tex.

revival of activity at this mine in 1916 to 1920, with a yield of roughly 8,000 flasks. The extensive workings in section 59 are now termed the "Mariposa mine", and exploration here is being conducted by the Chisos Mining Co. The northern part of California Mountain contains rather closely spaced workings in an area about 1,500 by 875 feet. They extend to a depth of a little more than 300 feet below the collar of the Cruz or No. 5 shaft, which is on the northwest side of California Mountain. A little ore remains in the old stopes here and there, and the ore bodies are irregular in detail. The older part of the mine has been explored rather thoroughly. There is an area south of the present development that appears to have some possibility.

Within a radius of about 2 miles north of California Mountain are numerous workings. With minor exceptions, the production in this part of the area has been small, and most of the properties are now idle. Only the larger ones are shown on figure 30. In the northern part of section 58 desultory work has been done for several years. A little mercury has been produced, but as yet there has been no intensive development. Work in this area was done on the Monte Cristo claim in 1934 by the Tarrant Mining Co. A small amount of development work was accomplished, but in the latter part of the year operations ceased. The northwest part of section 58 is controlled by the Tres Cuevas Quicksilver Co.

In section 44 and contiguous parts of other sections there has been a great deal of prospecting, but no extensive workings have been developed. In several cuts ore has been exposed, and a small amount has been retorted. Some prospecting has been done in section 42, which seemingly has not as yet developed any ore.

In section 40, block G12, there are several occurrences of mercury. This property formerly belonged to the Terlingua Quicksilver Co., one of the earliest operators and producers. Claims covering most of the section are now held by the Waldron Quicksilver Properties, Inc. Late in 1934 this company resumed mining near the center of the section. The company's main camp is at the Colquitt-Tigner mine in section 38.

Summarizing, the western part of the Terlingua district contains many workings, most of them small. The first development work in this district was done here, and the major part of the output was obtained shortly after the discovery. Ore continues to be mined intermittently up to the present. The principal recent work is the exploration by the Chisos Mining Co. in the old Mariposa mine, which has resulted in the mining of some ore and the resumption of activities of the Waldron Quicksilver Co., Inc.

Eastern part.—The eastern part of the Terlingua district contains the only two settlements of any size in the district—Terlingua and Study Butte. The mines are scattered more widely than in the western part of the district, but have likewise been more productive. In this part of the district the most westerly development of present importance is at the Rainbow mine in sec. 70, block G12. This property was opened in 1900, and it is reported that about $10,000 worth of mercury was obtained from shallow cuts and drifts at that time. During the World War a 600-foot shaft was sunk but failed to develop any ore. Recently drifts from the bottom of this shaft have encountered rich ore bodies. The Rainbow shaft now has a reported depth of 670 feet. Short drifts, partly caved, extend from it at intervals of 50 feet and less down to the 550-foot level, where about 400 feet of drifting has been done without opening up any ore bodies. On the 600-foot level there are nearly 5,000 feet of workings. This is the main working level. Some of the stopes extend down to the 635-foot level. When visited in 1934 this mine was in steady operation, supplying ore of good grade to a 10-ton rotary furnace.

The Chisos mine is by far the largest and most productive in the district. The mine workings lie immediately east of the Rainbow property. The company owns secs. 295, 296, 284, and 297 and part of secs. 286, 298, and 248, all in block G4, and sec. 69, block G12, as well as claims in sec. 70, block G12. The company also has a lease on sec. 59, block G12. The property is equipped with a 20-ton Scott furnace, a rotary furnace (now inactive), offices and shops, a hotel or camp boarding house, a store, and numerous buildings for housing its personnel. The mine has been in operation almost continuously from about 1902 until the latter part of 1934. The maximum depth attained is said to be more than 825 feet. On the 725-foot level water was encountered, which is said to interfere with operations in the lower part of the mine.

East of the Chisos is a property belonging to the Waldron Quicksilver Properties, known as the "Two-forty-eight." Ore has been exposed on the lowest level, which is about 80 feet below the surface, and the property was in operation late in 1934.

At Study Butte in sec. 216, block G4, lying near the eastern border of the district, are two mining companies, the Big Bend Mining Co. and the Texas-Almaden Mining Co. This area is reported to have produced about $500,000 worth of mercury between 1915 and 1920. Since 1928 the Brewster Quicksilver Consolidated has been operating the mines under lease. This company has been producing mercury steadily, using a rotary furnace, although the low prices during the depression caused some curtailment of activity. The mine contains water, which rises approximately to the level of the nearby creek channel when not kept down by pumping. In consequence of the high cost of pumping, recent operations have been confined to workings above the 200-foot level. On this level the best of the known ore bodies have already been mined. New ore bodies continue to be found in the upper workings, but the future of the mine depends on development at depth, where drifting and diamond drilling are reported to have yielded encouraging results.

The total production of mercury from the Terlingua district to date is probably well over 125,000 flasks, and roughly three-fourths of this production has come from the eastern part.

MARISCAL DISTRICT

The old Mariscal or Lindsey mine is the only mine in the Mariscal district that has been developed extensively, work being done here as early as 1900. It has been reported that from 1917 to 1921 some 1,300 flasks of mercury were produced, but of late little has been done. The main shaft is 438 feet deep, but its lower part is now inaccessible. Drifts have not yet been extended from it far enough to test the ore body at depth. Stoping is confined to a series of irregular workings which have a maximum over-all length of about 500 feet and extend along an incline to a depth of about 100 feet.

On Mariscal Mountain, north and west of the Lindsey mine, are several short tunnels and shallow shafts, some of which are reported to have found ore. None of these has been worked for years. Some development work was begun in April 1934 on an unprospected vein a short distance northwest of the north end of Mariscal Mountain.

The Mariscal district has received relatively little attention from mining men, owing to its inaccessibility. The quantity of cinnabar that has been found during the small amount of development work suggests that further exploration may be justified.

In the outlying areas cinnabar has been reported to occur near Fresno Canyon, southwest of the Terlingua district; the Mesa de Anguilla; Christmas Mountains; places east of Study Butte, and also near Laguna in the Chisos Mountains, where float ore but no outcrops have been reported. Little development work has been done in any of these localities.

WASHINGTON

The production of mercury in 1934 was larger than that in 1933 and was all from near Morton, Lewis County. The Roy Mining Co. was the largest producer, followed by B. H. Parmenter, operating the Barnum McDonell mine, and the Spencer Mining Co.

PRODUCTIVITY OF LABOR IN MINES AND PLANTS

The annual presentation of a table indicating the number of producers and the average output per man is based upon a hypothesis that such a table will indicate, among other things, the relationship of production to man power and also establish a ratio between the cost of labor and the gross value of a unit of product.

As can be seen in the table that follows, since 1926 the number of pounds of mercury produced per man-hour has increased. In 1926 domestic ores treated yielded an average of 0.54 percent mercury (10.8 pounds per ton). In 1933 and 1934 the average was 0.41 percent (8.2 pounds per ton), and notwithstanding the indicated decline in tenor of ore treated the per-hour recovery increased from 0.64 pound in 1926 to 0.98 pound in 1932 and 0.85 pound in 1933. To make this comparison relatively sound, it is to be noted from the table on page 440 that the index price for 1926 was $64.13 a flask; 1932, $62.42; 1933, $62.74; and 1934, $68.84.

As an indicated use of this table, let it be assumed that the average wage paid labor engaged in the mercury industry in 1926 was $3.75 per shift. This wage scale was unchanged in 1933, although according to the Bureau of Labor Statistics the purchasing power of the dollar in terms of wholesale prices of all commodities was 52 percent greater than in 1926. In 1926 the value of the output per man-shift was $6.17, therefore the percentage of cost of labor to the whole was 61. In 1933 the value per man-shift was $5.28, and the percentage of labor cost was 71.

The output of mercury per man during the period under discussion increased due to a number of reasons. The greater use of engineers and technical men at the mines and better-trained mining and metallurgical crews have resulted in improved mining methods and better metallurgical practice. In later years the decreased prices brought a demand for lower costs of production. The general shutting down of inefficient properties, the mining of richer veins in the properties that continued to operate, and the elimination of much exploratory work contributed to the increased recovery per man-hour.

Employment at mercury mines and plants in the United States, mercury produced, and average output per man, 1924–33

Year	Employment									Production					
	Average number of men employed			Time employed						Total (flasks of 76 pounds)	Covered by study			Average pounds per man (mines and plants)	
				Man-shifts			Man-hours								
	Mines	Plants	Total	Mines	Plants	Total	Mines	Plants	Total		Flasks	Equivalent pounds	Percent of total	Per shift	Per hour
TOTAL UNITED STATES															
1924	304	43	347	101, 025	14, 139	115, 164	808, 200	113, 112	921, 312	9, 952	9, 308	707, 408	94	6. 14	0. 77
1925	279	43	322	89, 931	11, 113	101, 044	719, 448	88, 904	808, 352	9, 053	8, 513	646, 988	94	6. 40	. 80
1926	283	30	313	89, 606	8, 175	97, 781	716, 848	65, 400	782, 248	7, 541	6, 559	498, 484	87	5. 10	. 64
1927	364	104	468	120, 570	24, 645	145, 215	964, 560	197, 180	1, 161, 740	11, 128	8, 062	612, 712	72	4. 22	. 53
1928	517	141	658	167, 184	38, 080	205, 264	1, 358, 277	304, 540	1, 662, 817	17, 870	14, 251	1, 083, 076	80	5. 28	. 65
1929	748	222	970	217, 920	58, 467	276, 387	1, 764, 310	470, 549	2, 234, 859	23, 682	20, 114	1, 528, 664	85	5. 53	. 68
1930	665	231	896	201, 695	58, 852	260, 547	1, 778, 830	470, 816	2, 249, 646	21, 553	19, 731	1, 499, 556	92	5. 76	. 67
1931	752	221	973	213, 499	57, 166	270, 665	1, 745, 869	464, 226	2, 210, 095	24, 947	22, 772	1, 730, 672	91	6. 39	. 78
1932	331	137	468	75, 810	26, 761	102, 571	606, 498	214, 087	820, 585	12, 622	10, 580	804, 080	84	7. 84	. 98
1933	286	113	399	70, 406	22, 068	92, 474	562, 682	172, 669	735, 351	[1] 9, 669	8, 234	625, 784	85	6. 77	. 85
CALIFORNIA															
1928	254	74	328	83, 225	17, 622	100, 847	665, 800	140, 976	806, 776	6, 977	6, 571	499, 396	94	4. 95	. 62
1929	419	134	553	116, 413	29, 316	145, 729	931, 304	235, 088	1, 166, 392	10, 139	9, 214	700, 264	91	4. 81	. 60
1930	335	150	485	98, 820	33, 862	132, 682	790, 560	270, 896	1, 061, 456	11, 451	10, 791	820, 116	94	6. 18	. 77
1931	396	136	532	105, 710	31, 420	137, 130	846, 497	256, 105	1, 102, 602	13, 448	12, 547	953, 572	93	6. 95	. 86
1932	144	73	217	23, 766	9, 853	33, 619	190, 082	78, 823	268, 905	5, 172	4, 247	322, 772	82	9. 60	1. 20
1933	116	59	175	22, 988	7, 436	30, 424	183, 332	57, 207	240, 539	[1] 3, 930	3, 497	265, 772	89	8. 74	1. 10
OTHER STATES															
1928	263	67	330	83, 959	20, 458	104, 417	692, 477	163, 564	856, 041	10, 893	7, 680	583, 680	71	5. 59	. 68
1929	329	88	417	101, 507	29, 151	130, 658	833, 006	235, 461	1, 068, 467	13, 543	10, 900	828, 400	80	6. 34	. 78
1930	330	81	411	102, 875	24, 990	127, 865	988, 270	199, 920	1, 188, 190	10, 102	8, 940	679, 440	88	5. 31	. 57
1931	356	85	441	107, 789	25, 746	133, 535	899, 372	208, 121	1, 107, 493	11, 499	10, 225	777, 100	89	5. 82	. 70
1932	187	64	251	52, 044	16, 908	68, 952	416, 416	135, 264	551, 680	7, 450	6, 333	481, 308	85	6. 98	. 87
1933	170	54	224	47, 418	14, 632	62, 050	379, 350	115, 462	494, 812	5, 739	4, 737	360, 012	83	5. 80	. 73

[1] Revised figures.

FOREIGN TRADE [9]

Mercury imported into the United States, 1930–34, by countries [1]

Country	1930		1931		1932		1933		1934 [1]	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Belgium					7,606	$3,100				
Canada	5	$9					30	$7		
France										
Germany										
Hong Kong										
Italy					261,972	98,907	244,076	109,729	49,285	$33,339
Mexico	10,716	13,747	445	$622	221	199	156,056	74,464	188,494	120,914
Peru										
Spain	212,965	282,073	26,609	32,027	346,090	128,637	1,292,553	584,769	536,025	326,635
Sweden									760	600
United Kingdom					760	571	21,449	9,038		
	223,686	295,829	27,054	32,649	616,649	231,414	1,714,164	778,007	774,564	481,488

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

Mercury compounds imported for consumption in the United States, 1933–34

Compound	1933		1934	
	Pounds	Value	Pounds	Value
Chloride (mercuric) (corrosive sublimate)	33	$35		
Chloride (mercurous) (calomel)	1,050	1,002	1,112	$1,243
Oxide (red precipitate)	8	14		
Mercury preparations (not specifically provided for)	669	1,000	427	866
Vermilion reds (containing quicksilver)	25,559	20,147	27,435	26,159
		22,198		28,268

Exports.—Statistics for the exports of mercury were discontinued during 1933 and have not been resumed. Data concerning this phase of the industry are not available.

WORLD PRODUCTION

The following table shows the world production of mercury by countries from 1930 to 1934.

[9] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

World production of mercury, 1930–34, by countries

[Compiled by L. M. Jones, of the Bureau of Mines]

[1 metric ton = 29.008 flasks of 76 pounds]

Country [1]	1930		1931		1932		1933		1934	
	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons
Algeria	325	11.2	1,073	37.0	1,184	40.8	(2)	(2)	(2)	(2)
Australia: Queensland			11	.4	26	.9			(2)	(2)
Austria	72	2.4	72	2.5	23	.8	5	.2	(2)	(2)
Bolivia [3]			1,021	35.2	505	17.4			(2)	(2)
Chile	(4)	(4)	20	.7	8	.3	(2)	(2)	(2)	(2)
China	[5] 725	[5] 25.0	[5] 638	[5] 22.0	[3] 99	[3] 3.4	[3] 368	12.7	(2)	(2)
Chosen	26	.9	41	1.4	26	.9			(2)	(2)
Czechoslovakia	2,060	71.0	2,222	76.6	1,305	45.0	194	6.7	(2)	(2)
Italy	56,069	1,932.9	37,652	1,298.0	29,480	1,016.3	17,590	606.4	(2)	(2)
Japan	121	4.2	101	3.5	69	2.4	234	8.1	(2)	(2)
Mexico	4,946	170.5	7,292	251.4	7,350	253.4	4,478	154.4	4,580	157.9
New Zealand	52	1.8	450	15.5	2	.1	99	3.4	(2)	(2)
Rumania			8	.3	2	.1	8	.3	(2)	(2)
Spain	19,221	662.6	19,786	682.1	23,656	815.5	19,626	676.6	(2)	(2)
Turkey	537	18.5	235	8.1			23	.8	(2)	(2)
U. S. S. R. (Russia) [6]	3,278	113.0	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
United States	21,553	743.0	24,947	860.0	12,622	435.1	9,669	333.3	15,445	532.4
	108,985	3,757.0	[7] 95,569	[7] 3,294.7	[7] 76,357	[7] 2,632.4	(2)	(2)	(2)	(2)

[1] In addition to countries listed Taiwan reported production of 488 kilograms of cinnabar in 1931; mercury content not stated.
[2] Data not available.
[3] Exports.
[4] Chile reported 69 kilograms of metallic mercury produced in 1930.
[5] Approximate production (Imp. Inst., London).
[6] Year ended Sept. 30.
[7] Exclusive of U. S. S. R.

Algeria.—Official statistics for Algeria have not been available since 1932.

Germany.—The German policy of restricting the imports of deficiency minerals has affected the importations of mercury. Under the present severe restrictions and search for substitutes it may well be that the domestic consumption will decline steadily.

Italy.—Owing to the depression in the mercury industry the production of Monte Amiata was practically at a standstill, stocks being sufficient to meet present requirements. Only the Idria mines, which were taken over from Austria after the World War, are working at something near capacity, being subsidized by the Government. The production of the other mines was greatly reduced.[10]

Mercury and mercury ores were added to the list of goods, the exportation of which may be prohibited, allowed under permit, or subject to export quota restrictions by a decree of September 27, 1934, according to a report of October 5, 1934 from Trade Commissioner Elizabeth Humes, Rome. The reported purpose of this measure is to enable the Italian Government to prevent violations of the Italo-Spanish agreement concerning the marketing of mercury.

A report on the mercury mine at Idria, dated October 19, 1932, and prepared by Rollin R. Winslow, American consul, Trieste, Italy, has been drawn upon freely for the benefit of those interested in the future supply of mercury.

[10] McBride, John L., commercial attaché, Rome, Italy, Jan. 16, 1935.

The Idria mercury mine is approximately 300 meters above sea level in the foothills of the Julian Alps, Province of Gorizia, along the Idria River. The mine was discovered by accident in 1497 by a peasant who was collecting spring water and noticed particles of mercury on the bottom of his bucket.

Between 1500 and 1813 the mine passed through various hands as a result of wars or by succession. In 1509 the Venetians conquered the district and came into possession of the mine, but it was repossessed by the Austrians a year later. Up to 1580 the mine was operated without great success by private concerns, so the Austrian Government purchased it and operated it on its own account. A special department was created and the territory around the mine was included in a reserve in which private research or mining was forbidden.

In 1797 Napoleon allotted to Bernadotte (later King of Sweden) "a substantial share of the booty of the rich quicksilver mine at Idria, and he accepted it".[11] In 1813 the mine was returned to Austria, after which it became the most important mercury mine in Europe. After 1918 the mine was taken over by the Italian Government and since then has been operated by it.

According to Lindgren[12] the ores of the Idria mine are found in Triassic beds of shale, marl, and dolomite and now are apparently connected with and in part occur in great overthrusts and faults.

The mineral extracted is principally cinnabar containing 0.2 to 2 percent pure mercury. The ratio of the rich to the poor mineral (containing respectively 6 to 7 percent and 0.4 to 0.5 percent pure mercury) ranges from 1:25 to 1:30.

The Regia Miniere d'Idria (royal mine of Idria) is situated in the village of Idria and represents its principal and in fact (except for lumber) only industry. The mine covers a greater area than the village. The Idria River flows through the mining district and provides power for the mine operations. The maximum depth reached is 357 meters below the surface. There are 14 levels, the total length of which is about 40 miles.

Under normal circumstances about 1,200 persons are employed in the mine, but when Winslow's report was made (October 1932) about 600 were employed. The labor, with but few exceptions, is all local. The mine is under the supervision of the royal commissary in charge, an engineer appointed by the Department of Mines, Ministry of Corporations, at Rome.

No information is obtainable concerning the cost of production, but it is undoubtedly quite low in view of the prevailing wage scale. Since the work is attended by considerable risk and the Government suffers some losses by theft the wages in mercury mining probably are greater than the prevailing wage for coal mining, which is, roughly, $1.25 to $1.50 a day.

[11] Barton, Dunbar Plunket, The Amazing Career of Bernadotte: John Murray, London, 1929, p. 50.
[12] Lindgren, Waldemar, Mineral Deposits: 1913, p. 466.

Mercury produced in Italy, 1931–32

Province	Ore mined						Metal produced				
	Number of mines	Number of workmen	Metric tons	Tenor (per cent)	Value [1]	Tons per man	Number of plants	Number of workmen	Flasks (76 pounds)	Value [1]	Flasks per man
1931											
Cagliari (Iglesias)[2]							(2)	(2)	87	$5,857	(2)
Gorizia (Trieste)	1	707	69,640	0.628	$667,123	99	1	115	10,356	864,897	90
Grosseto (Firenze)	5	460	52,692	.370	139,085	115	4	160	4,612	360,936	29
Siena (Firenze)	4	626	73,957	1.060	1,429,662	118	3	425	22,597	1,763,497	53
	10	1,793	196,289	.720	2,235,870	109	8	700	37,652	2,995,187	[3] 54
1932											
Cagliari (Iglesias)[2]							(2)	(2)	63	3,123	(2)
Gorizia (Trieste)	1	624	59,739	.660	217,082	96	1	97	9,758	363,978	101
Grosseto (Firenze)	4	260	26,280	.370	20,204	101	4	164	2,480	110,198	15
Siena (Firenze)	4	960	41,741	1.300	579,764	43	3	341	17,179	763,014	50
	9	1,844	127,760	.810	817,050	69	8	602	29,480	1,240,313	[3] 49

[1] Lire converted to dollars at the average annual rate of exchange, as published by the U. S. Federal Reserve Board.
[2] Product recovered in the plant of the Società di Monteponi from condensation of mercury vapor obtained in lead smelting.
[3] Exclusive of output at Cagliari.

Japan.—Numerous new discoveries of mercury deposits have been reported from time to time in Japan proper, Chosen, and Formosa but none developed into important mines. The small annual production of this commodity is obtained from the Yamato mercury mine in Nara Prefecture and from the Tokuho mine in Chosen. On the other hand, imports for 3 years have shown a continued and steady increase, Italy, Spain, and Great Britain being the chief sources of supply.

Mexico.—According to the Mexican Ministry of Economics considerable quantities of mercury are being shipped from that country to Japan. Japanese mining interests in Mexico are understood to be the source.[13]

During 1934 certain mercury deposits in the northern part of Durango, Mexico, were examined briefly by Frank L. Hess of the Bureau of Mines; the statements made herein are based upon his observations during this visit.

The district lies in the northern part of Durango and is approximately 135 kilometers south of Parral, State of Chihuahua. One of the most promising prospects seems to be El Porvenir, which lies about 65 kilometers south of Rosario, the nearest railroad point. The country rock is a quartzose granite overlain by a limestone conglomerate and numerous lava flows. The ore is found in a fault cutting the lava and the older rocks. Due to the fault and accompanying it is a brecciated mass some 50 feet or more thick. This breccia has been altered greatly and is now changed largely to clay and iron oxide. Owing to the various movements along the fault lenses with slickensides have been formed in the breccia, and as is usual in such masses mercury has been deposited from solutions which have flowed from one subsidiary fault to another, making it difficult to follow the ore. The cinnabar is associated with heavy iron oxides which undoubtedly will change to pyrite in depth. At the time of

[13] Daily Metal Reporter, Jan. 8, 1935.

Hess' visit it was stated that about 2,000 tons of ore had produced 48,000 pounds of mercury. Approximately 50 men were employed at El Porvenir. The present operating company is Compania Exploradora de Durango, S. A., Rosario, State of Durango, Mexico.

Approximately 15 miles northwest of El Porvenir is a group of claims known as the Colorado. There are a number of veins in which cinnabar occurs. The ore is almost always accompanied by more or less fluorite. In some places the fluorite reaches a thickness of 20 to 30 feet, occupying part of a shear zone which may be as much as 75 feet thick, with some chloritization of the adjoining conglomerate. A small retort was being built at the time of the visit, but all work ceased before the end of the year.

Two or three miles north of the Colorado claims is a shear zone in rhyolite approximately 75 feet wide, which crosses the trail from Rosario to Guanacevi at the junction of Arroyo Baluarta and Arroyo Rosario. A number of small fissures in this sheared zone are lined with pyrite (now all oxidized), coated thinly with cinnabar. A small furnace capable of handling perhaps 100 pounds of ore per day had been operated, but the output is not known. The ore treated was hand-picked and said to have carried 5 percent mercury. The ore occurring in this locality might be concentrated by flotation or by a table-concentrating plant.

Spain.—Although the Almaden mine usually is referred to when mention is made of the mercury production in Spain, nevertheless some cinnabar has been mined in Oviedo in the north, and ore also has been partly developed in the Provinces of Murcia and Granada.

Mercury produced in Spain, 1932–33

Province	Ore mined					Metal produced				
	Number of mines	Number of workmen	Metric tons	Value [1]	Tons per man	Number of plants	Number of workmen	Flasks (76 pounds)	Value [1]	Flasks per man
1932										
Ciudad Real	1	1,541	10,334	$127,604	6.71	1	440	23,401	$940,871	53.18
Granada	1	30	1,697	4,741	56.57	1	24	255	13,650	10.63
	2	1,571	12,031	132,345	7.66	2	464	23,656	954,521	50.98
1933										
Ciudad Real	1	1,505	9,297	167,530	6.18	1	445	19,626	1,051,568	44.10
Granada	1	30	47	191	1.57					
Oviedo	1	33	950	2,380	28.78					
	3	1,568	10,294	170,101	6.57	1	445	19,626	1,051,568	44.10

[1] Pesetas converted to dollars at the average annual rate of exchange, as published by the U. S. Federal Reserve Board.

U. S. S. R. (Russia).—The first Russian concentrating plant for mercury ores has been put into operation in Nikitovka in the Donetz Valley. The ores are obtained from the Nikitovka mine and assay 0.2 to 0.3 percent mercury. It is claimed that the concentrates produced will assay 15 to 20 percent mercury. The Russian mercury output in 1929 was 3,771 flasks and in 1930, 3,278 flasks. No figures are available for production in later years. Imports, according to the Imperial Institute, London, were 1,013 flasks in 1931 and 26 flasks in 1932.

MANGANESE AND MANGANIFEROUS ORES [1]

By Robert H. Ridgway

SUMMARY OUTLINE

World production and consumption of manganese ore during 1934 benefited by the continued rise in the world output of steel—to nearly 80,000,000 long tons. Price quotations in the world markets reflected the better demand, and the increased domestic consumption in the U. S. S. R. (Russia), the principal world producer, tended to relieve the pressure of price competition. Figures for the world production of manganese ore in 1934 are not yet available, but preliminary returns indicate that they exceeded those of 1933 and may have reached 2,800,000 metric tons. Operations in Brazil and Egypt were virtually at a standstill during the year, but production was larger in the Gold Coast and the U. S. S. R. (Russia), and export figures for India showed a considerable increase. Large increases in exports were made from the two newer sources—the Union of South Africa and Cuba.

In the United States 1934 was characterized by increases in domestic production, imports, consumption, and price. Stocks in bonded warehouses, however, declined. The following table outlines the principal statistics for the manganese industry during the past 10 years.

[1] Figures on imports and exports in the United States compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Salient statistics of the manganese industry in the United States, 1925–34, in long tons

	1925–29 average	1930	1931	1932	1933	1934
Manganese ore:						
Total shipments containing 35 percent or more manganese	59,312	67,035	39,242	17,777	[1] 19,146	26,514
Shipments of metallurgical ore	[2] 41,892	53,326	29,874	9,963	9,527	14,978
Shipments of battery ore	17,420	11,757	7,952	7,012	7,904	8,889
Imports for consumption	600,000	454,625	293,137	90,782	288,187	341,339
Stocks in bonded warehouses at end of year	304,000	413,216	613,814	622,489	490,819	430,714
Indicated consumption (35 percent or more manganese)	659,000	524,196	334,753	110,861	[1] 308,971	369,564
Ferro-alloys:						
Production of ferromanganese	306,360	274,830	166,937	56,350	136,267	139,171
Imports of ferromanganese [3 4]	[5] 50,590	44,037	19,836	14,779	31,759	18,702
Production of spiegeleisen	95,463	87,059	67,800	37,317	26,683	(6)
Imports of spiegeleisen [3]	7,298	13,406	9,482	8,364	26,277	21,184
Exports of spiegeleisen and ferromanganese	3,769	6,189	1,306	33	47	222
Stocks of ferromanganese in bonded warehouses	[4 5] 7,765	9,793	6,745	6,173	6,424	7,124

[1] Revised figure.
[2] Includes small quantity of miscellaneous ore.
[3] Imports for consumption.
[4] Manganese content.
[5] Includes small quantity of other manganese alloys.
[6] Not at liberty to publish.

The trend of imports and production of manganese ore from 1900 to 1934 is shown graphically in figure 31.

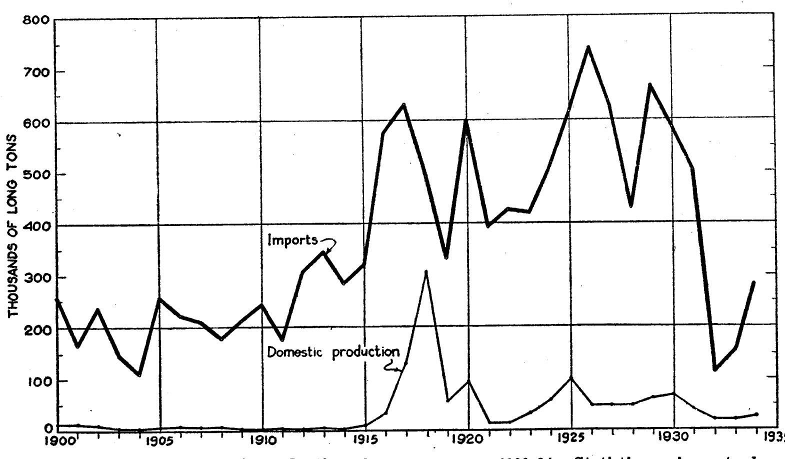

FIGURE 31.—Imports and domestic production of manganese ore, 1900–34. Statistics on imports shown in the graph represent "general imports" for the period 1900–33; beginning with 1934 data classified as "general imports" were not available, and the figure plotted for that year represents imports for consumption adjusted for changes in stocks in bonded warehouses. For all practical purposes the 1934 figure can be regarded as closely comparable with the record for earlier years.

Code activity under N. R. A.—A proposed code of fair competition of the manganese industry was submitted to the National Recovery Administration on August 24, 1933, by the American Manganese Producers Association, which represented 90 percent of the known members of the industry in volume of production. The original draft was revised several times before the public hearing on January 26, 1934, and further revisions were made during the recess of this hearing. The code was approved on May 11, 1934, by the Administrator for Industrial Recovery who stated the following in his report to the President, accompanying the code:

> Because of the stagnant condition of the industry, an industry in the strict interpretation of the Act does not exist. Because of the fact that manganese does occupy a pivotal position as an emergency war material, and also because of the fact that the industry did, under stress of war demands and high prices, produce up to 38 percent of our requirements, the sponsor's application for a Code of Fair Competition for the Manganese Industry has been granted.

The industry, as defined by the code, "includes the mining in the United States, including Territories, of manganese ore and/or the concentrating of and/or beneficiating of ores in which manganese constitutes the principal recoverable constituent of economic value, and the original sale of such products by the one producing and/or manufacturing the same either directly or indirectly through subsidiary and/or affiliated companies."

The administration of the code was vested in a code authority consisting of 9 voting members, of whom 5 were members of the executive committee of the American Manganese Producers Association and 4 were other members of the industry—not members of the executive committee but truly representative of the various interests of the industry and elected by a fair method of selection approved by the Administrator. In addition, provision was made for 1 and not more than 3 members without vote appointed by the Administrator.

Labor clauses in the code established a maximum working week of 40 hours for employees engaged in mining and processing products. Minimum rates of pay prescribed in the code range from 40 cents per hour above ground and 47½ cents an hour underground in the Northwestern section to 30 and 35 cents, respectively, in the Southern section. Other labor clauses set forth provisions respecting the rights of employees to organize and bargain collectively, reclassification of employees, standards of health, and child labor.

Marketing and trade practices specified in the code required, among other things, that each member of the industry within 10 days after the effective date of the code should file with the code authority the price or prices and terms and conditions of sale at which he was offering his products. Any subsequent changes in price or conditions of sale became effective immediately after the revised schedule was filed with the code authority.

An amendment to the code, submitted late in 1934 and approved by the National Industrial Recovery Board February 15, 1935, permitted a maximum 48-hour week for hoist, pump, and power-house men.

Trade agreement with Brazil.—On February 2, 1935, the United States and Brazil signed a trade agreement providing for reciprocal tariff concessions which included a reduction of 50 percent in the tariff on Brazilian manganese ore imported into the United States. The agreement must be approved by the Brazilian Congress and will not come into force until 30 days after the instruments of ratification by the President of Brazil and the approval of the United States have been exchanged. Approval of the treaty by the United States Senate is not required under the authority conferred on the President by Congress in the Trade Agreements Act approved June 12, 1934.

The agreement with Brazil is based upon the principle of unconditional most-favored-nation treatment and upon the consequent assumption that the concessions each country grants to the products of the other, in the absence of special considerations, will, as a rule, be extended to like products of other countries.

From the standpoint of the domestic producing and consuming industries the chief interest in the proposed reduction in tariff relates to the possible reduction in price not only of manganese ore but also of ferromanganese. For an ore containing 50 percent manganese the cost to the consumer will be reduced $5.60 per long ton; roughly, the cost of manganese ore necessary to make a long ton of standard ferromanganese will be decreased $10 to $11.

Domestic producers petition the President.—Taking the position that a domestic manganese industry should be maintained to provide employment and for purposes of national defense, 41 Senators and 145 Representatives from 33 States signed a petition recommending "all just and proper actions that may be necessary to insure maintenance and further development of the manganese mining industry in the United States." This petition was submitted by the Domestic Manganese Producers Association to the President on June 28, 1934, and was accompanied by a letter from the producers' association recommending:

(1) Enforcement of title III of the Treasury-Post Office Appropriation Act so as to require domestic manganese in steel used on public works.

(2) Prompt action toward limitation of manganese imports under section 3 (*e*) of N.I.R.A., so as to allow proper operation of the code and further employment of labor.

(3) Purchase and storage of domestic manganese ore by the War Department for future emergency needs.

Planning Committee for Mineral Policy.—A report by the planning committee for mineral policy to the National Resources Board dealt with the immediate problem of controlling surpluses and the long-time problem of conservation. The report, which was included as a part of the report of the National Resources Board to the President, was released early in 1935.

Part 4 of section 2 of the committee's report deals with conservational problems relating to mineral commodities of which there is a deficiency in the domestic supply. Manganese ore is one of the few mineral commodities in which the United States is notably deficient and in the past tariffs have been imposed to encourage production from domestic sources. Regarding the use of tariffs in stimulating the development of new deposits the committee states:

> In practice, however, the encouragement of tariffs has not greatly aided exploration, discovery, and research; on the contrary, the stimulus of a protected market of uncertain duration has merely accelerated the depletion of the few high-grade deposits we have at a time when consideration for national defense requires that such limited supplies be conserved for emergency use. The wisdom, moreover, of tariff protection for minerals of which the small (actual or potential) domestic production meets only a minor portion of consumption requirements is open to further questions with which the Committee is not primarily concerned.

In lieu of tariff protection the committee believes that a more effective procedure would be to increase direct appropriations to continue surveys, exploration, and technical experiments, particularly on manganese, in order to effect its recovery from large, low-grade deposits already known in the United States. Tariff protection should be given careful consideration after adequate supplies have been found and made available at costs somewhat above world prices.

Part 3 of the section designated "International Aspects of Mineral Policy" deals with foreign trade in minerals for which the United States depends partly or wholly on outside sources. With respect to this group, which includes manganese, the committee recommends: (1) Consideration of tariffs in the light of domestic reserves; (2) protection of American interests against attempts to maintain excessive prices on our needed imports; (3) restriction or regulation of the export of scrap; (4) establishment of war reserves of imported minerals essential for national defense; and (5) maintenance of trading lines carrying these minerals.

In considering national defense and imported minerals, the committee believes that reliance must be placed on stocks within the country plus possible domestic production. The stock-pile reserves may be obtained by one or a combination of the following several methods:

1. By purchase in domestic or world markets.
2. By accepting materials in lieu of tariff duty payments.
3. By accepting materials in partial payment of war debts.
4. By using emergency relief funds to stimulate domestic mining.

Such stock piles should be held inviolate by the Government until actually required for war needs. The estimated essential reserve of 50-percent manganese ore suitable for the manufacture of ferromanganese for a 2-year emergency is given as 1,000,000 short tons.

DOMESTIC PRODUCTION

The production of manganese ore totaled 26,514 long tons containing (dried) about 44 percent manganese in 1934, compared with 19,146 (revised figure) tons containing (dried) about 46 percent manganese in 1933. Expanded activity in the domestic iron and steel industry resulted in increased demand for both foreign and domestic metallurgical-grade manganese ores. Shipments of metallurgical-grade ores increased from 9,527 tons in 1933 to 14,978 tons in 1934. Increases also were recorded for shipments of domestic ferruginous manganese ores and domestic manganiferous iron ores. Shipments of battery-grade ores (concentrates) increased from 7,904 tons in 1933 to 8,889 tons in 1934. The following table covers shipments of manganese-bearing ores for the last 5 years:

Manganiferous raw materials shipped in the United States, 1930–34, in long tons

Year	Metallurgical ore [1]				Battery ore [2]	Miscellaneous manganese ore
	Manganese ore (35 percent or more manganese)	Ferruginous manganese ore (10 to 35 percent manganese)	Manganiferous iron ore (5 to 10 percent manganese)	Manganiferous zinc residuum		
1930	53,326	77,417	707,973	113,060	11,757	1,952
1931	29,874	64,062	217,352	96,990	7,952	1,416
1932	9,963	15,635	9,799	25,320	7,012	802
1933	9,527	12,779	178,852		7,904	[3] 1,715
1934	14,978	28,231	198,591	65,236	8,889	2,647

[1] Ferrous metallurgy only.
[2] Recorded as "chemical manganese ore" in reports of this series prior to 1930.
[3] Revised figure.

Shipments of the various grades during the last 5 years are given by States in the following tables.[2]

Metallurgical manganese ore shipped from mines in the United States, 1930–34, by States, in long tons

State	1930	1931	1932	1933	1934
Alabama	-	-	267	806	-
Arizona	364	-	-	-	-
Arkansas	3,276	4,028	1,306	1,890	5,842
California	162	40	-	-	158
Georgia	18,897	6,491	200	1,565	6,281
Montana	22,731	17,088	8,190	987	1,657
Nevada	1,489	-	-	-	-
New Mexico	2,574	1,072	-	-	-
North Carolina	60	-	-	-	-
Tennessee	471	70	-	-	-
Texas	247	155	-	-	-
Virginia	3,055	901	-	4,184	1,040
West Virginia	-	29	-	95	-
	53,326	29,874	9,963	9,527	14,978

Ferruginous manganese ore shipped from mines in the United States, 1930–34, by States, in long tons

State	1930	1931	1932	1933	1934
Alabama	321	1,321	4,328	2,810	1,404
Arizona	48	-	-	-	-
Arkansas	12,645	2,230	208	1,060	1,374
Colorado	19,730	3,685	-	-	-
Georgia	12,009	11,652	9,700	8,505	9,166
Idaho	1,450	578	-	-	-
Michigan	-	2,217	-	-	-
Minnesota	4,698	26,567	1,399	-	-
Montana	11,875	14,311	-	-	11,247
Nevada	3,363	-	-	-	-
Tennessee	113	-	-	-	-
Utah	10,972	1,501	-	-	-
Virginia	193	-	-	404	40
	77,417	64,062	15,635	12,779	23,231

Manganiferous iron ore shipped from mines in the United States, 1930–34, by States, in long tons

State	1930	1931	1932	1933	1934
Alabama	-	-	217	685	-
Georgia	-	-	-	-	31
Michigan	-	-	9,582	6,445	595
Minnesota	693,546	217,352	-	171,722	197,622
New Mexico	14,427	-	-	-	-
Wisconsin	-	-	-	-	343
	707,973	217,352	9,799	178,852	198,591

Battery ore [1] shipped from mines in the United States, 1930–34, by States

Year	Montana (long tons)	Virginia (long tons)	Total	
			Long tons	Value
1930	11,451	306	11,757	$432,668
1931	7,802	150	7,952	281,523
1932	7,012	-	7,012	239,267
1933	7,904	-	7,904	$265,766
1934	8,889	-	8,889	295,649

[1] Recorded as "chemical manganese ore" in reports of this series prior to 1930.

[2] In addition, manganiferous zinc residuum was produced in New Jersey; miscellaneous ores came from Arizona, Montana, Tennessee, and Virginia.

IMPORTS OF MANGANESE ORE

Imports for consumption of manganese ore into the United States in 1934 totaled 341,339 long tons containing 165,840 tons of manganese. Of the imports for consumption in 1934, 36.6 percent was from the U. S. S. R. (Russia), 21.6 percent from the Gold Coast, 18.7 percent from Cuba, and 16.4 percent from Brazil.

Manganese ore imported into the United States, 1932–34, by countries [1]

Country	Manganese ore (long tons)			Manganese content (long tons)			Value		
	1932	1933	1934 [1]	1932	1933	1934 [1]	1932	1933	1934 [1]
Brazil	21,500		55,834	9,495		24,483	$199,382		$418,342
Canada	27	(²)	1,520	13	(²)	840	1,000	$20	32,442
Chile		445	1,133		211	567		3,116	7,103
China		2			1			43	
Cuba	6,749	28,257	63,743	3,416	14,573	31,431	111,770	430,906	965,610
Egypt			50			28			2,452
France			(²)			(²)			9
Germany	25	14	17	13	8	9	1,380	988	1,334
Gold Coast	24,592	43,768	73,656	12,203	22,391	36,913	349,648	429,515	982,953
Hong Kong		1			1			32	
India (British)	1,750		20,550	910		10,493	18,200		216,381
Netherland East Indies	529	526		282	291		14,817	11,317	
U. S. S. R. (Russia)	55,437	83,780	124,836	27,206	41,890	61,076	521,868	499,406	902,556
United Kingdom	25	43		15	24		1,318	2,979	
	110,634	156,836	341,339	53,553	79,390	165,840	1,219,383	1,378,322	3,529,182

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.
[2] Less than 1 ton.

Stocks.—For the second consecutive year, stocks of manganese ore in bonded warehouses decreased materially and at the end of 1934 totaled 430,714 long tons containing 213,251 tons of manganese metal compared with 490,819 tons containing 238,040 tons of metal at the close of 1933. The figure for 1934 is the lowest reported since 1930.

Tariff.—The status of manganese ore in the tariff bill of 1930 is given on page 315 of the 1930 Mineral Resources chapter on Manganese and Manganiferous Ores. The tariff was not changed in 1934, but early in 1935 the United States signed a trade agreement with Brazil (yet to be ratified) which reduces the tariff on Brazilian ore 50 percent. Similar tariff considerations may be extended to other countries.

Prices of manganese ore.—The prices of metallurgical ore trended upward strongly in 1934; those for battery-grade ores maintained at about the 1933 level.

Prices of manganese ore according to grade and origin, as quoted by the various trade journals, are for imported ore and (except for battery ore) are on a unit basis, the unit being 1 percent of a long ton (22.4 pounds of metallic manganese). Prices of battery-grade ore are quoted on a per-ton basis, with a minimum requirement of manganese dioxide.

The prices quoted in the following table are from the Engineering and Mining Journal and indicate the upward trend during 1934:

Domestic prices of metallurgical manganese ore, 1934, in cents per long-ton unit

[C. i. f. North Atlantic ports, cargo lots, exclusive of duty]

	Brazilian, 46-48 percent manganese	Chilean, 47 percent manganese [1]	Indian, 48-50 percent manganese	Caucasian, 52-55 percent manganese [1]	South African	
					49-51 percent manganese	44-48 percent manganese
January 1	19	22½	20	22	22	21
April 1	22	23	24	24	23	22
July 1	22	23	24	24	23	22
October 1	23	26	25	26	24	23
December 31	24	26	25	26	26	24

[1] Nominal.

According to the Engineering and Mining Journal the prices for chemical (battery) ores during 1934 were as follows: Domestic chemical ores containing 70 to 72 percent manganese dioxide were quoted at $40 to $50 a ton in carload lots during the year. Imported chemical ores containing a minimum of 80 to 85 percent manganese dioxide were quoted at $45 to $60 a ton throughout the year.

CONSUMPTION OF MANGANIFEROUS RAW MATERIALS

The manufacturing industries in the United States that consume manganese ore fall into three main groups: The metallurgical industry, the battery industry, and miscellaneous industries. The first group consumes by far the largest quantity, whereas the third group has little importance when the total consumption of manganese ore is considered but has significance to the small producers of specialty ores.

Expanded activity in steel production, the principal use of manganese ore, was accompanied by large increases in the consumption of manganese and manganiferous ores in 1934 compared with 1933.

The following table shows the indicated consumption of manganiferous raw materials in the United States in 1933 and 1934. The table does not consider differences in consumers' stocks at the beginning and end of the year. As such stocks are largely imported ore and the import figure used in the table is that for "imports for consumption", it is thought that the change in stocks would not be great because the manganese ore may be kept in bond until withdrawn for consumption. The duty is then paid, and the ore is reported as imports for consumption.

Indicated consumption of manganiferous raw materials in the United States, 1933–34

	Ore containing 35 percent or more manganese		Ore and residuum containing 10 to 35 percent manganese		Ore containing 5 to 10 percent manganese	
	Long tons	Manganese content (percent)	Long tons	Manganese content (percent)	Long tons	Manganese content (percent)
1933						
Domestic shipments	[1] [2] 20,784	[3] 45	12,779	26	178,852	7.8
Imports for consumption	288,187	49	[4] 260	25	[4] 51,399	6.7
Total available for consumption	[3] 308,971	49	13,039	26	230,251	7.6
1934						
Domestic shipments	[1] 28,225	[3] 43	88,467	16	198,591	7.7
Imports for consumption	341,339	49	[4] 614	21	[4] 104,587	8.0
Total available for consumption	369,564	48	89,081	16	303,178	7.8

[1] Includes shipments from Puerto Rico. [2] Revised figures. [3] Partly estimated. [4] Estimated.

Besides the material shown in the foregoing table, 635,254 long tons of iron ore containing 2 to 5 percent manganese presumably were used in the manufacture of manganiferous pig iron in 1934 compared with 538,248 tons in 1933. Figures for imports of this class of ore are not available.

METALLURGICAL INDUSTRY

Although manganese ore is used in both the ferrous and nonferrous metallurgical industries, the bulk is consumed in the manufacture of iron and steel. Most of the ore entering this industry is used in the manufacture of ferromanganese and spiegeleisen, the forms in which manganese usually is added to steel.

Chief manganese alloys imported into and made from domestic and imported ores in the United States, 1933–34, in long tons

	1933		1934	
	Alloy	Manganese	Alloy	Manganese
Ferromanganese:				
Imported	39,693	31,759	23,349	18,702
Domestic production	136,267	108,059	139,171	109,491
From domestic ore [1]	5,196	4,157	354	283
From imported ore [1]	131,071	103,902	138,817	109,208
Total	175,960	139,818	162,520	128,193
Ratio (percent) of manganese in ferromanganese of domestic origin to total manganese in ferromanganese made and imported		2.97		0.22
Number of plants making ferromanganese	5		6	
Spiegeleisen:				
Imported	26,277	[1] 5,255	21,184	[1] 4,237
Domestic production	26,683	5,306	(2)	(2)
From domestic ore [1]	4,998	994	(2)	(2)
From imported ore [1]	21,685	4,312	(2)	(2)
Total	52,960	10,561	(2)	(2)
Ratio (percent) of manganese in spiegeleisen of domestic origin to total manganese in spiegeleisen made and imported		9.41		(2)
Number of plants making spiegeleisen	4		3	
Total available supply of metallic manganese as alloys		150,379		(2)
Percentage of available supply of manganese in—				
Ferromanganese and spiegeleisen imported		24.61		(2)
Ferromanganese made from imported ore		69.09		(2)
Spiegeleisen made from imported ore		2.87		(2)
Ferromanganese made from domestic ore		2.77		(2)
Spiegeleisen made from domestic ore		.66		(2)
Ferromanganese and spiegeleisen made from domestic ore		3.43		(2)
Spiegeleisen made and imported		7.02		(2)
Total open-hearth and Bessemer steel	22,810,463		25,693,462	

[1] Estimated. [2] Not at liberty to publish.

Ferromanganese.—Production of ferromanganese in 1934 totaled 139,171 long tons compared with 136,267 tons in 1933 and was made at 6 plants by 6 different operators. The bulk of the output came from blast-furnace plants, but an increased quantity was recorded from electric furnaces due to production in 1934 from a new plant at Alloy, W. Va. The following plants manufactured ferromanganese in 1934:

Bethlehem Steel Co., Johnstown, Pa.
Electro Metallurgical Co., Alloy, W. Va.
Lavino Furance Co., Sheridan, Pa.
Pittsburgh Metallurgical Co., Niagara Falls, N. Y.
Tennessee Coal, Iron & Railroad Co., Ensley, Ala.
United States Steel Corporation, Etna, Pa.

In addition to the above plants, shipments were reported from the plant of the Colorado Fuel & Iron Co., Pueblo, Colo.

The domestic production of ferromanganese in 1934 used 256,980 long tons of foreign manganese ore, 853 tons of domestic manganese ore, 13,933 tons of domestic iron ore, and 3,304 tons of cinder, scale, and scrap.

Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1930–34

Year	Ferromanganese produced			Materials consumed (long tons)				Manganese ore used per ton of ferromanganese made (long tons)
	Long tons	Manganese contained		Manganese ore		Iron and manganiferous iron ores	Cinder, scale, and scrap	
		Percent	Long tons	Foreign	Domestic			
1930	274,830	78.59	216,000	459,478	32,969	51,039	9,712	1.792
1931	166,937	78.59	131,200	287,973	12,277	19,214	3,405	1.799
1932	56,350	77.66	43,760	90,677	10,666	5,270	1,499	1.798
1933	136,267	79.30	108,059	233,607	10,695	10,795	1,655	1.793
1934	139,171	78.67	109,491	256,980	853	13,933	3,304	1.853

The following table shows, by sources, the foreign manganese ore consumed in the manufacture of ferromanganese from 1930 to 1934. The undistributed ore reported in 1934 is believed to have originated mainly in Africa and Cuba.

Foreign manganese ore used in manufacture of ferromanganese in the United States, 1930–34, in long tons

Source of ore	1930	1931	1932	1933	1934
Africa	62,913	26,133	5,135	30,427	18,076
Brazil	138,757	62,630	25,279	42,805	55,778
Chile	1,705	4,363		1,046	451
Cuba			2,126	28,275	16,242
India	44,667	26,267	11,541	22,499	21,460
U. S. S. R. (Russia)	211,436	168,580	46,596	108,555	116,953
Undistributed					28,020
Total	459,478	287,973	90,677	233,607	256,980

Shipments of ferromanganese in 1934 were 147,947 long tons valued at $12,345,697, an increase of 16 percent in quantity over 1933. The trend of shipments during the last 5 years has been as follows:

Ferromanganese shipped from furnaces in the United States, 1930–34

Year	Long tons	Value	Year	Long tons	Value
1930	273,640	$25,865,783	1933	127,453	$9,384,611
1931	159,168	12,999,329	1934	147,947	12,345,697
1932	70,417	5,061,029			

Although there is a slight export trade in ferromanganese the quantity manufactured in the United States is supplemented by imports. Ferromanganese imported for consumption in 1934 included 261 tons containing not over 1 percent carbon.

Ferromanganese imported into and exported from the United States, 1930–34

Year	Imports for consumption			Exports [1]	
	Gross weight (long tons)	Manganese content (long tons)	Value	Gross weight (long tons)	Value
1930	(2)	44,037	$4,021,040	6,189	$145,629
1931	24,664	19,836	1,751,646	1,306	38,506
1932	18,470	14,779	1,091,026	33	2,369
1933	39,693	31,759	2,548,068	47	3,393
1934	23,349	18,702	1,441,360	222	12,580

[1] Include spiegeleisen; not separately classified.
[2] Not recorded.

Norway, Canada, and the United Kingdom furnished the bulk of the imports into the United States in 1934; Norway alone furnished 66 percent. The following table shows the distribution of imports by countries for the last 2 years:

Ferromanganese [1] imported into the United States, 1933–34, by countries [2]

Country	1933 [1]		1934 [2]	
	Manganese content (long tons)	Value	Manganese content (long tons)	Value
Belgium			21	$1,100
Canada	19,011	$1,754,460	2,226	250,443
France	155	18,353	440	43,814
Germany	980	31,914	79	4,105
Italy	198	24,572	516	69,704
Netherlands	39	1,314	258	11,855
Norway	11,732	852,576	12,387	884,760
Poland and Danzig	219	8,779	734	41,043
Sweden	84	3,555		
United Kingdom	24	11,773	2,041	134,536
	32,442	2,707,296	18,702	1,441,360

[1] Includes small quantities of other manganese alloys in 1933.
[2] Data on total imports in 1934 and 1933 are not strictly comparable, due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

Ports into which imported ferromanganese entered in 1933 and 1934 were as follows:

Manganese content of ferromanganese [1] imported into the United States, 1933–34, by ports of entry, in long tons [2]

Port of entry	1933 [1]	1934 [2]	Port of entry	1933 [1]	1934 [2]
Buffalo	16,100	2,449	Ohio		393
Chicago	2,140	516	Oregon		75
Galveston	20	43	Philadelphia	2,071	3,508
Los Angeles		266	San Francisco	500	288
Maryland	5,380	7,642	Washington (State)	270	249
Michigan	3,260	372			
New Orleans	2,421	2,204		32,442	18,702
New York	280	697			

[1] Includes small quantities of other manganese alloys in 1933.
[2] Data on total imports in 1934 and 1933 are not strictly comparable, due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

Stocks of ferromanganese in bonded warehouses at the end of 1934 totaled 7,124 long tons containing 5,814 tons of manganese metal.

The status of ferromanganese in the Tariff Bill of 1930 is given on page 321 of the 1930 Mineral Resources chapter on Manganese and Manganiferous Ores.

The price of ferromanganese was maintained nearly constant during 1934, and at the end of the year it was quoted at $89.79 per long ton of 80-percent alloy delivered at Pittsburgh. The quotations for the last 3 years have been as follows:

Prices per long ton of ferromanganese in the United States, 1932–34 [1]

[80 percent—delivered at Pittsburgh]

Month	1932	1933	1934	Month	1932	1933	1934
January	$79.85	$73.24	$90.24	July	$73.24	$84.44	$89.79
February	80.24	73.24	90.24	August	73.24	87.24	89.79
March	80.24	73.24	90.24	September	73.24	87.24	89.79
April	80.24	73.24	90.24	October	73.24	87.24	89.79
May	80.24	73.24	90.24	November	73.24	87.24	89.79
June	74.99	73.24	90.00	December	73.24	87.24	89.79

[1] Steel, vol. 96, Jan. 7, 1935.

Spiegeleisen.—Shipments of spiegeleisen declined from 50,218 long tons in 1933 to 45,769 tons in 1934, as shown in the following table.

Spiegeleisen produced and shipped in the United States, 1930–34

Year	Produced (long tons)	Shipped from furnaces		Year	Produced (long tons)	Shipped from furnaces	
		Long tons	Value			Long tons	Value
1930	87,059	94,918	$2,469,861	1933	26,683	50,218	$1,144,642
1931	[1] 67,800	55,327	1,313,068	1934	(2)	45,769	1,099,922
1932	37,317	31,071	745,966				

[1] Steel, Manganese Ore and Alloy Statistics: Vol. 90, no. 1, Jan. 4, 1932, p. 198.
[2] Not at liberty to publish.

Spiegeleisen was manufactured at the following plants in 1934:

New Jersey Zinc Co., Palmerton, Pa.
Tennessee Coal, Iron & Railroad Co., Ensley, Ala.
United States Steel Corporation, North Braddock, Pa.

In addition to the above plants, spiegeleisen was shipped from the following plants in 1934:

Colorado Fuel & Iron Co., Pueblo, Colo.
Lavino Furnace Co., Sheridan, Pa., and Reusens, Va.

Most of the spiegeleisen produced in the United States is made from domestic raw materials, but 11,840 long tons of foreign manganese ore were consumed in the manufacture of spiegeleisen in 1934.

Imports of spiegeleisen for consumption were 21,184 long tons valued at $595,017 in 1934 compared with 26,277 tons valued at $640,613 in 1933. All imports for consumption in 1934 came from Canada and Norway, Canada furnishing 95 percent.

Spiegeleisen imported for consumption in the United States, 1930–34

Year	Long tons	Value	Year	Long tons	Value
1930	13,406	$381,197	1933	26,277	$640,613
1931	9,482	247,788	1934	21,184	595,017
1932	8,364	192,037			

The following table shows the price quotations of spiegeleisen by months for the last 3 years:

Prices per long ton of spiegeleisen in the United States, 1932–34 [1]

[20 percent—at producers' furnaces]

Month	1932	1933	1934	Month	1932	1933	1934
January	$27.00	$24	$26	July	$25.00	$27	$26
February	27.00	24	26	August	25.00	27	26
March	27.00	24	26	September	25.00	27	26
April	27.00	24	26	October	25.00	27	26
May	27.00	24	26	November	24.25	27	26
June	26.50	24	26	December	24.00	27	26

[1] Steel, vol. 96, Jan. 7, 1935.

Manganiferous pig iron.—Precise data on the consumption of manganiferous ores in the production of manganiferous pig iron are not available; however, 198,591 long tons of domestic ore containing 5 to 10 percent manganese and 635,254 tons of domestic ore containing 2 to 5 percent were shipped in 1934. Foreign manganiferous iron ore (104,587 long tons) and foreign ferruginous manganese ore (614 tons) also were consumed in the manufacture of pig iron. The sources of the foreign ores for the last 3 years appear in the following table. In 1932 the ferruginous manganese ore contained material consumed in the manufacture of ferromanganese and spiegeleisen. Import figures on ore containing 2 to 5 percent manganese are not available.

Foreign ferruginous manganese ore and manganiferous iron ore consumed in the United States, 1932–34, in long tons

Source of ore	Ferruginous manganese ore			Manganiferous iron ore		
	1932	1933	1934	1932	1933	1934
Africa	91			8,818		9,836
Australia	6,213		263	33,210	51,399	54,390
Brazil			351			
Canada	143	260				
Cuba	1,215					
Spain						32,888
Sweden						7,473
Undistributed	6,705					
Total	14,367	260	614	42,028	51,399	104,587

BATTERY INDUSTRY

Shipments of manganese ore by domestic producers to battery makers in 1934 totaled 8,889 long tons, and shipments from Puerto Rico were 1,711 tons. These figures indicate a consumption of 10,600 tons of domestic materials in battery manufacture. Imported manganese ore also was consumed in the battery industry, but no figures are available for such imports.

MISCELLANEOUS INDUSTRIES

Manganese ore is also consumed in the chemical, ceramic, and glass industries. Certain ores with peculiar physical or chemical properties are required for the manufacture of special articles in these industries. The preparation and handling of ore for some of the miscellaneous uses has been described by Chambers.[3] Domestic manganese ore shipped to these industries totaled 2,647 long tons in 1934.

REVIEW BY STATES

The following table shows shipments of manganese-bearing ore in 1933 and 1934, by States:

Manganese and manganiferous ore shipped by mines in the United States, 1933–34, by States

	Ore containing 35 percent or more manganese			Ore containing 10 to 35 percent manganese			Ore containing 5 to 10 percent manganese		
	Shippers	Long tons	Value	Shippers	Long tons	Value	Shippers	Long tons	Value
1933									
Metallurgical:									
Alabama	2	806	$9,930	8	2,810	$17,267	1	685	$1,416
Arkansas	1	1,890	(1)	1	1,060	(1)			
Georgia	3	1,565	(1)	7	8,505	36,386			
Michigan							1	6,445	19,817
Minnesota							4	171,722	450,134
Montana	1	987	(1)						
Virginia	(2) 7	4,184	60,111	1	404	(1)			
West Virginia	1	95	(1)						
Undistributed			95,101			4,184			
Total metallurgical	15	9,527	165,142	17	12,779	57,837	6	178,852	471,367

1 Included under "Undistributed."
2 One producer in Montana shipped both battery and miscellaneous ore and 4 producers in Virginia shipped both metallurgical and miscellaneous ore.

3 Chambers, Gordon H., Manganese: Foote-Prints, vol. 7, no. 2, December 1934, pp. 11–20.

Manganese and manganiferous ore shipped by mines in the United States, 1933–34, by States—Continued

	Ore containing 35 percent or more manganese			Ore containing 10 to 35 percent manganese			Ore containing 5 to 10 percent manganese		
	Shippers	Long tons	Value	Shippers	Long tons	Value	Shippers	Long tons	Value
1933									
Battery:									
Montana	[2,3] 2	7,904	$265,766						
Total battery	2	7,904	265,766						
Miscellaneous:									
Montana	[2] 2	429	[4] 35,377						
Tennessee	[4] 1	[4] 588							
Virginia	[2] 5	698							
Total miscellaneous	[4] 8	[4] 1,715	[4] 35,377						
	[4] 20	[4] 19,146	[4] 466,285	17	12,779	$57,837	6	178,852	$471,367
1934									
Metallurgical:									
Alabama				7	1,404	7,878			
Arkansas	3	5,842	(1)	1	1,374	(1)			
California	4	158	1,500						
Georgia	6	6,281	(1)	11	9,166	(1)	1	31	41
Michigan							1	595	(1)
Minnesota							3	197,622	510,017
Montana	[5] 2	1,657	(1)	2	11,247	43,484			
Virginia	[5] 3	1,040	14,922	1	40	300			
Wisconsin							1	343	(1)
Undistributed			203,003			56,610			2,760
Total metallurgical	18	14,978	219,425	22	23,231	108,272	6	198,591	512,818
Battery:									
Montana	[3,5] 2	8,889	295,649						
Total battery	2	8,889	295,649						
Miscellaneous:									
Montana	[5] 2	1,002	56,674						
Tennessee	1	1,088							
Virginia	[5] 4	557							
Total miscellaneous	7	2,647	56,674						
	24	26,514	571,748	22	23,231	108,272	6	198,591	512,818

[1] Included under "Undistributed."
[2] One producer in Montana shipped both battery and miscellaneous ore and 4 producers in Virginia shipped both metallurgical and miscellaneous ore.
[3] Mills through which all ore was shipped; producers not counted.
[4] Revised figures.
[5] One producer in Montana and 1 in Virginia shipped both metallurgical and miscellaneous ore, and 1 producer in Montana shipped both battery and miscellaneous ore.

Alabama.—There were no shipments of manganese ore from Alabama in 1934. Shipments of ferruginous manganese ore in 1934 were 1,404 long tons containing (dried) 23 percent manganese compared with 2,810 tons containing (dried) 29 percent manganese in 1933. The bulk of the output came from Cherokee County, with smaller amounts from Etowah and Calhoun Counties.

Arkansas.—Shipments of manganese ore from Arkansas in 1934 were 5,842 long tons containing (dried) 43 percent manganese. All of the output in 1934 came from Independence County, where Walter H. Denison and A. B. Reither furnished the bulk of the shipments. Walter H. Denison also shipped 1,374 tons of ferruginous manganese ore containing (dried) 31 percent manganese from Independence County.

Mining developments within the last several years in the Batesville district, Arkansas, have disclosed extensions of previously known deposits of manganese, so that the former estimates of reserves by the United States Geological Survey of both high- and low-grade ores should be greatly increased, in the opinion of H. D. Miser, of the Geological Survey, who recently visited the district.

California.—Four operators in California shipped 158 long tons of manganese ore containing 43 percent manganese in 1934. There were no shipments from California in 1932 or 1933. The output came from Lake, Riverside, San Bernardino, and Sonoma Counties.

Georgia.—All shipments of manganese ore from Georgia in 1934 came from the Cartersville district in Bartow County. Shipments were 6,281 long tons containing (dried) 39 percent manganese. The bulk of the output came from the operations of the Manganese Corporation of America.

Shipments of ferruginous manganese ore were 9,166 long tons containing (dried) 25 percent manganese in 1934. Virtually all of the shipments of this class of material came from the Cartersville district, the Manganese Corporation of America being the principal shipper.

In addition, 31 tons of manganiferous iron ore containing (dried) 7.6 percent manganese were shipped in 1934 from the Cartersville district.

Michigan.—Shipments of manganiferous iron ore from Michigan in 1934, which amounted to 595 long tons, came from the Balkan-Judson mine in Iron County and contained (dried) 8.95 percent manganese, 44.66 percent iron, 4.61 percent silica, and 0.556 percent phosphorus.

Minnesota.—There were no shipments of ferruginous manganese ore from Minnesota in 1933 or 1934, but shipments of manganiferous iron ore totaled 197,622 long tons in 1934, compared with 171,722 tons in 1933. All shipments in 1934 came from the Cuyuna Range and averaged (dried) 8.91 percent manganese. The principal producer was the Sagamore mine at Riverton; other shipments came from the Wearne mine at Crosby and the Hillcrest stock pile at Ironton.

Montana.—Shipments of metallurgical manganese ore from Montana in 1934 were 1,657 long tons, virtually all from the sintering plant of the Domestic Manganese & Development Co. at Butte, where a high-grade sinter containing (dried) 64.81 percent manganese was produced from the rhodochrosite ores from the Emma mine.

Shipments of battery-grade ore were 8,889 long tons in 1934 and came from the Philipsburg district, where the Trout Mining Co. and the Moorlight Mining Co. produce battery-grade concentrates by magnetic separation. The concentrates averaged about 72 percent MnO_2.

Shipments of ores for miscellaneous purposes totaled 1,002 long tons in 1934. The Emma mine at Butte and one operator in the Philipsburg district supplied this class of ore.

Shipments of tailings from the Trout Mining Co. totaled 10,278 long tons in 1934. The tailings averaged (dried) 23.85 percent manganese and were shipped to the Columbia Steel Co. at Provo, Utah, where they are added to the blast-furnace burden.

Tennessee.—One operator in Tennessee shipped 1,088 long tons of manganese ore in 1934. The ore, which contained (dried) 65 percent MnO_2, moved to the Tennessee Eastman Corporation where it is consumed in the manufacture of chemicals.

Virginia.—Shipments of manganese ore from Virginia were 1,597 long tons in 1934 compared with 4,882 tons in 1933. Of the total shipments in 1934, 1,040 long tons were metallurgical ore and 557 tons were for miscellaneous uses. Shipments were made by six producers in Augusta, Bland, Campbell, Page, Scott, and Shenandoah Counties.

Wisconsin.—Shipments of manganiferous iron ore from Wisconsin in 1934 were 343 long tons; the output came from the Cary mine at Hurley in Iron County and averaged (dried) 8.18 percent manganese and 50.89 percent iron. This is the first year in which shipments have been recorded from Wisconsin since 1927.

Puerto Rico.—Shipments of manganese ore in 1934 were 1,711 long tons containing 854 tons of manganese compared with 1,638 tons containing 797 tons in 1933.

The entire output of the island comes from the mine of the Atlantic Ore Co. about 3 miles from Juana Diaz. The ore occurs as a replacement deposit in folded band of Upper Cretaceous limestone.[4] Percolating waters have deposited irregular masses of pyrolusite, psilomelane, and manganite along fractures. Each pocket of manganese ore is isolated more or less by thick pillars of pure limestone which must be penetrated to extract the ore. The ore, however, is of excellent quality.

Small-scale mining operations at or near the surface have been carried on for 16 years, but systematic mining operations will soon be necessary. The extent of the reserves is unknown, but the supply in the small area in which the ore has been proved should be adequate for a number of years. There are possibilities of manganese deposition at other points on the limestone bed which may extend the life of the operation indefinitely.

Producers of domestic manganese ore.—The following list comprises producers and shippers of domestic manganese ore (35 percent or more manganese) in 1934:

Producers and shippers of domestic manganese ore (35 percent or more manganese in natural state) in 1934

Arkansas:
- Walter H. Denison, Cushman.
- L. Peterson, Cushman.
- A. B. Reither, Cushman.

California:
- Henry von Glahn, Middletown.
- C. M. Langdon, Blythe.
- E. F. Logan, Newberry.
- M. R. Shriver, Santa Rosa.

Georgia:
- Harry B. Brown, Cartersville.
- Manganese Corporation of America, White.
- H. L. Simpson, Cartersville.
- B. C. Sloan, Cartersville.
- Frank D. Smith, Cartersville.
- Southern Mining Co., Inc., Cartersville.

Montana:
- Anaconda Copper Mining Co., Butte.
- Domestic Manganese & Development Co., Butte.
- Moorlight Mining Co., Philipsburg.
- Trout Mining Co., Philipsburg.

Tennessee:
- Tennessee Manganese Corporation, Spruce Pine, N. C.

Virginia:
- Hy-Grade Manganese Co., Inc., Woodstock.
- L. L. Powers, Dungannon.
- Southern Mines & Metals, Inc., Lynchburg.
- Stange Mining Co., Inc., Crandon.
- Stanley Manganese Mines, 1817 Thirty-seventh Street NW., Washington, D. C.

[4] Meyerhoff, Howard A., Geology of Puerto Rico: University of Puerto Rico Monographs, ser. B, no. 1, 1933, pp. 133–34.

WORLD PRODUCTION

The following table shows, so far as statistics are available, the world production of manganese ores from 1930 to 1934 and their average manganese content. Most figures are from official statistics of the countries concerned, supplemented by data from semiofficial and other sources.

Manganese ore produced in the principal countries, 1930–34, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country [1]	Percentage of manganese	1930	1931	1932	1933	1934
North America:						
Canada (shipments)		497	176			
Cuba	36–50+	762	96	9,800	28,000	68,000
Mexico	40+	732	731	[2] 700	573	664
United States:						
Continental (exclusive of fluxing ore)	35+	68,111	39,872	18,062	19,453	26,940
Puerto Rico [3]	48–58	2,577	2,412	2,339	1,664	1,738
South America:						
Argentina [4]		239	221	252	410	(5)
Brazil	38–50	206,831	147,349	20,300	25,000	7,527
Chile [3]	40–50	6,137	383	449	(5)	(5)
Europe:						
France	30+	1,000			(5)	(5)
Germany	30+	2,349		12	563	(5)
Greece	30+	655	356	745	(5)	(5)
Hungary	30	9,090	1,132	1,497	6,232	(5)
Italy	30–50	10,633	6,421	378	4,524	(5)
Rumania	42	33,528	18,787	5,051	2,774	(5)
Spain	29+	16,819	17,916	2,591	2,834	(5)
Sweden	35–45+	4,907	4,140	3,014	5,895	(5)
U. S. S. R. (Russia)	41–48	[6] 1,444,166	876,000	915,300	998,000	1,821,000
Yugoslavia	42–45	1,539	2,454	160	535	(5)
Asia:						
China [3]	50–55	54,854	22,051	20,733	9,574	(5)
India:						
British	47–52	843,267	546,476	216,016	221,811	(5)
Portuguese	42–50+	5,476	3,547	3,573	1,600	(5)
Japan	50+	19,588	12,849	26,242	43,535	(5)
Netherland India (East Indies)	45–56	16,690	14,541	8,287	10,463	(5)
Turkey	40	900	1,000	2,800	7,700	13
Africa:						
Egypt	30+	121,211	101,781	327	187	(5)
Gold Coast [3]	50+	453,773	226,889	51,502	269,395	344,832
Morocco (French)	40–50+	16,200	11,502	3,980	4,800	3,407
Northern Rhodesia	41–50	887	1,491		5,453	2,074
Union of South Africa	40–60	147,321	101,899		21,229	(5)
Oceania:						
Australia:						
New South Wales		127		108	131	(5)
South Australia			13	20	2	
New Zealand [3]	52+	2				(5)
		3,491,000	2,162,000	1,314,000	1,694,000	(5)

[1] In addition to the countries listed Belgium is reported to produce a small quantity of manganese ore, but statistics of output are not available. Czechoslovakia reports a production of "manganese ore", but as it has been ascertained that the product so reported averages less than 30 percent manganese and therefore would be considered ferruginous manganese ore under the classification used in this report the output has not been included in the table.
[2] Approximate production.
[3] Exports.
[4] Shipments by rail and river.
[5] Data not available.
[6] Year ended Sept. 30.

Brazil.—Shipments of manganese ore from Brazil virtually were suspended during the entire year due to the low demand and keen competition. Production was only 7,527 metric tons, the lowest on record since production was begun. Exports were only 2,300 tons in 1934 compared with 24,893 tons in 1933 and 293,318 tons in 1929.

Virtually all the production of manganese ore in Brazil has come from the State of Minas Geraes. A Brazilian decree (no. 24043) dated

March 26, 1934,[5] specifically and exceptionally exempts the State of Minas Geraes, along with Bahia and Rio de Janiero, from complying with the provisions of Brazilian decree no. 21418 of May 17, 1932, which required Brazilian States to abolish State export duties gradually at the rate of 20 percent each year beginning in 1933. Such action was deemed necessary because revenues obtained from the export duties are pledged to foreign loans or otherwise earmarked. The export duties on manganese ore in Minas Geraes are on a graduated scale, depending on the manganese content, and are subject to monthly changes. In April 1934 the duty on ore containing more than 50 percent manganese was 92 cents per metric ton when converted to American currency at the nominal rate.

On February 2, 1935, the United States and Brazil signed a reciprocal trade agreement which, among other concessions, provided for a reduction of 50 percent in the present American duty on manganese ore imported from Brazil. If confined to Brazil, the lowered duty will inevitably stimulate production there. If, however, the reduction in duty is granted other nations supplying the American market, Brazil will have no competitive advantage due to the agreement.

Cuba.—Production of sintered and unsintered concentrates in Cuba during 1934 totaled 68,000 metric tons. The sintered concentrates average 52 percent manganese. Continuous monthly operations of the Cuban-American Manganese Corporation property were resumed April 1, 1934.

All manganese ore produced in Cuba moves to the United States where Cuban ore has a 100-percent tariff preference. The reciprocal trade agreement between the United States and Cuba, which became effective September 3, 1934, did not disturb the manganese tariff position; the ore still is admitted into the United States free of duty. The proposed 50-percent reduction in the American tariff on manganese from Brazil, resulting from the Brazilian-American trade agreement, may have an adverse effect on the development of manganese-ore production in Cuba, particularly if the tariff reduction is granted to other nations. This reduction of duty may lower the price to American consumers below the cost of producing sintered concentrates in Cuba. Such costs are high due to consumption of flotation reagents necessary to separate the manganese minerals from the gangue.

Gold Coast.—The production of manganese ore in the Gold Coast in 1934 was 371,038 metric tons. Exports of manganese ore from the Gold Coast during 1934 were 344,832 metric tons, a substantial increase over the 269,395 tons exported during 1933. The only producing mine in the Gold Coast is the Nsuta mine of the African Manganese Co., Ltd.

India.—Manganese mining in India, normally the world's second largest producer, improved considerably in 1934 over the 2 preceding years when the outputs were the lowest on record since 1904. Exports of ore from India, exclusive of exports through Mormugao, rose to 386,521 metric tons in 1934 compared with 263,520 tons in 1933 and 195,837 tons in 1932. Increased exports are moving through Vizagapatam owing to the recently improved port facilities and the completion of railroads which shorten the haul to the coast materially.

[5] Commerce Reports, Three Brazilian States Exempt from Obligation to Abolish State Export Duties: No. 18, May 5, 1934, p. 284.

During the year reduced freight rates were granted on ore consigned to Bombay. Production from the Central Provinces, the principal source of the better-grade Indian ores, still must go long distances by rail to the coast.

U. S. S. R. (Russia).—Preliminary figures indicate that production of manganese ore in the U. S. S. R. (Russia) in 1934 totaled 1,821,000 metric tons, a large increase over 1933. Increase in exports and in domestic steel production caused a considerably higher rate of output. Exports of manganese ore in 1934 were 736,877 metric tons compared with 655,007 tons in 1933. Of the total exports in 1934 Germany took 200,260 tons (27 percent); most of the German imports move by rail from the Nikopol district. Virtually all of the seaborne exports of manganese ore from the U. S. S. R. (Russia) come from the Chiaturi district and are shipped from the port of Poti on the Black Sea.

Exploitation of the Tukano-Sigasin manganese-ore deposits in the Abselilov district, Bashkir Republic, was begun in 1934. Three mines have been put into operation. The ore, which occurs near the surface, is reported [6] to run 56 and more percent manganese. The manganese ore will be hauled by truck to Magnitogorsk, 130 kilometers away. Discovery of other deposits in the Bashkir Republic, one at Faisuli and another 9 miles from Faisuli, were reported during the year. Extensive deposits of manganese ore also were reported discovered in the Petrovosko Sabaikal (Trans-Baikal),[7] in the Pervoma district north of Odessa,[8] and near Oyrotin [9] in western Siberia.

Union of South Africa.—Sales and shipments of manganese ore in the Union of South Africa were 66,893 metric tons in 1934 compared with 28,169 tons in 1933. The shipments averaged 50 percent manganese.

Virtually the entire output came from two companies, the Manganese Corporation, Ltd., and the South African Manganese, Ltd., both operating in the Postmasburg district where there are extensive reserves of high-grade ore. The Postmasburg district is in the very center of the Union of South Africa, 740 miles from the coast, which necessitates exceptionally heavy freight charges. Efforts by the producing companies to reduce freight rates were partly successful in 1934.

A committee of experts, after studying the results of experimental work, is reported [10] to have concluded that the production of ferromanganese in the Union of South Africa is uneconomic. The experiments were conducted by the Union Steel Corporation at the Newcastle pig-iron plant, using Postmasburg ores.

Other countries.—Exploitation of manganese ore from a group of claims located near Bangui Bay, Punta Negra, Luzon Island, P. I., was begun in 1934. Some 3,000 tons were shipped from this property in 1917. The ore is taken from opencuts and hand-picked on bamboo screens; the concentrates, which are nodules, run 28 to 50 percent manganese and are transported to the coast in bullock carts.

Renewed activities in manganese mining have been reported from Morocco, Czechoslovakia, Turkey, Bulgaria, and Portugal. The manganese deposits in France have been described by Charrin.[11]

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[6] Bureau of Foreign and Domestic Commerce, Manganese Deposits Discovered: Foreign Trade Notes, vol. 3, no. 9, Sept. 27, 1934, p. 15.

[7] Metal Bulletin, London, New Russian Discoveries: No. 1934, Oct. 23, 1934, p. 15.

[8] Metal Bulletin, London, New Russian Deposits: No. 1903, July 3, 1934, p. 15.

[9] Metal Bulletin, London, New Siberian Deposits: No. 1941, Nov. 16, 1934, p. 15.

[10] Metal Bulletin, London, No Production in South Africa: No. 1962, Feb. 1, 1935, p. 15.

[11] Charrin, V., Les Gîtes de Manganese en France: Génie civil, vol. 102, no. 18, May 6, 1933, pp. 419–421.

MOLYBDENUM

By Frank L. Hess [1]

SUMMARY OUTLINE

Molybdenum began to be used in metallurgy, especially in the metallurgy of iron and steel, later than nickel, vanadium, tungsten, or chromium, but has recently been making up for lost time; in fact, production has increased out of all proportion to that of the other metals named. In actual tonnage it is still a very minor metal, but the output of the world's greatest producer, the Climax Molybdenum Co., has multiplied 24.5 times from 1918 (its first year of production) to 1934—from 342,200 to 8,378,683 pounds of contained molybdenum in concentrates. Since the beginning of the Great War the production in the United States has risen even more spectacularly—from 1,297 pounds of molybdenum contained in concentrates sold for $1,297 in 1914 to 9,377,000 pounds valued at $6,502,000 in 1934.

The salient statistics for molybdenum are presented in the following table:

Salient statistics of the molybdenum industry in the United States, 1932–34 [1]

	1932	1933	1934
Production:			
Ore ... short tons	363,400	705,000	1,339,000
Concentrates ... do	2,387	5,348	9,119
Molybdenum contained:			
Average ... percent	50.93	53.12	51.33
Total ... pounds	2,431,000	5,682,000	9,362,000
Shipments (molybdenum contained):			
Pounds	2,373,000	5,761,000	9,377,000
Value [2]	$1,186,000	$4,316,000	$6,502,000
Imports (molybdenum contained):			
Pounds	44	670	213,928
Value	$89	$601	$124,156

[1] Figures for molybdenum exported not separately recorded. Producers report that probably four-fifths of the domestic output was exported in 1933 and 1934.
[2] Estimated by Bureau of Mines.

[1] Figures on imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Prices.—Molybdenite concentrates carrying 75 to 85 percent MoS_2 were quoted by the Engineering and Mining Journal of New York at 42 cents per pound of contained MoS_2 throughout the year. The Mining Journal of London quoted molybdenite concentrates at the beginning of the year at 45s. per long ton unit (22.4 pounds of MoS_2), the price falling to 35–36s. by the end of July and 34–35s. by the end of the year—equivalent to 50.7 cents, 39.3–40.4 cents, and 37.5–38.6 cents per pound of MoS_2, respectively.

Imports.—The duties on molybdenum and molybdenum products are of such a character that the market is to all intents and purposes strictly domestic. The Tariff Act of 1930 provides the following duties on molybdenum and molybdenum compounds:

PAR. 302. (*b*) Molybdenum ore or concentrates, 35 cents per pound on the metallic molybdenum contained therein. * * *

(*f*) Ferromolybdenum, metallic molybdenum, molybdenum powder, calcium molybdate, and all other compounds and alloys of molybdenum, 50 cents per pound on the molybdenum contained therein and 15 per centum ad valorem. * * *

PAR. 316. (*b*) Ingots, shot, bars, sheets, wire, or other forms, not specially provided for, or scrap, containing more than 50 per centum of tungsten, tungsten carbide, molybdenum, or molybdenum carbide, or combinations thereof; ingots, shot, bars, or scrap, 50 per centum ad valorem; sheets, wire, or other forms, 60 per centum ad valorem.

The imports for the past 10 years are shown in the following table:

Molybdenum ore and concentrates, ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum imported for consumption in the United States, 1925–34

Year	Molybdenum content (pounds)	Value	Year	Molybdenum content (pounds)	Value
1925	2,228	$2,977	1930	144,963	$283,846
1926	14,001	12,162	1931	210,766	213,660
1927	14,198	16,184	1932	44	89
1928	576	1,385	1933	670	601
1929	1,627	2,384	1934	213,928	124,156

DOMESTIC PRODUCTION

Arizona.—The Molybdenum Gold Mining Co., a subsidiary of the Molybdenum Corporation of America, continued operations throughout the year on the Mohawk and adjoining claims. The ore contains wulfenite and some gold. The increased price of gold makes practicable operation of the mine for the two metals.

The Arizona Molybdenum Corporation (433 South Spring Street, Los Angeles, Calif.) mined 29,493 tons of ore from its property on Copper Creek a few miles east of Mammoth, Pinal County; of this 27,780 tons were milled, yielding 317 tons of concentrates carrying 94.36 percent MoS_2, or 356,054 pounds of the element.

Mammoth-St. Anthony, Ltd., holding the Mammoth and Collins claims near Mammoth, did development work during the year but produced nothing.

Molybdenum, Inc. (Box 985, Tucson), operating a mine in the Helvetia district, Pima County, 15 miles east of Sahuarita, mined and milled 200 tons of ore, yielding 6½ tons of concentrates containing 90 percent MoS_2. A 30-ton flotation plant was installed; it began to handle ore about December 1.

Colorado.—The Climax Molybdenum Co. (500 Fifth Avenue, New York) at its mine at Climax, Lake County, Colo., carried on the largest mining operation of any kind in Colorado, as well as one of the largest in the United States. The company mined and treated 1,275,856 tons of ore, from which were extracted 7,780 tons of concentrates carrying 89.75 percent MoS_2, or 8,378,683 pounds of molybdenum.

Molybdenum (element) contained in concentrates produced from the Climax deposit, Colorado, 1918–34[2]

	Pounds		Pounds
1918	342, 200	1929	3, 529, 295
1919	152, 648	1930	3, 083, 000
1924	156, 935	1931	2, 644, 399
1925	821, 757	1932	1, 913, 395
1926	1, 057, 367	1933	5, 028, 695
1927	1, 858, 228	1934	8, 378, 683
1928	2, 957, 845		

Idaho.—The Molybdenum Products Co. (East 3258 Fifth Avenue, Spokane, Wash.) has molybdenite-bearing claims near Port Hill, Idaho, on which it is said a 30-ton mill was erected late in 1934, just before snow stopped further work.

Montana.—Frank C. Moore (P. O. Box 116, Melrose) reports having erected a small concentrating plant on Camp Creek with which to test molybdenite deposits during 1935.

Nevada.—The California Molybdenum Corporation (727 West Seventh Street, Los Angeles, Calif.), which for several years has been preparing the Shenandoah claim at Goodsprings, Nev., for production, produced 1,267 tons of wulfenite (lead molybdate, $PbMO_4$) ore, of which 1,063 tons were treated. A recovery of 118 tons of concentrates carrying 15.28 percent MoO_3 (10.19 percent Mo) was made.

New Mexico.—In Sulphur Gulch 7 miles east of Questa the Molybdenum Corporation of America (500 Fifth Avenue, New York) mined comparatively high-grade molybdenum ore. This property is one of the three largest molybdenum mines in the world, the others being those at Climax, Colo., and Cananea, Mexico.

Vermont.—J. R. Leahey and W. Osteyee (Rutland) report having an estimated 45,000 tons of rock carrying 1 percent Mo at Cuttingsville, Town of Shumway. Prospecting only has been done on the deposit.

WORLD PRODUCTION

Certain minerals may be widely disseminated throughout the earth's crust, although concentrated deposits of sufficient grade to make it possible to mine the ores commercially may occur only in a few places. Tin, mercury, nickel, and molybdenum are outstanding examples. The United States is deficient in the first three but produces about 80 percent of the world's molybdenum.

No important new discoveries or developments of molybdenum deposits in other countries were noted during the year.

[2] None produced, 1920–23, inclusive.

World production of molybdenum ores and concentrates, 1932–34

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	Mineral	Concentrates	Percent MoS_2	Contained molybdenum	Value
1932		*Metric tons*		*Metric tons*	
Australia:					
New South Wales	Molybdenite	3.6	(1)	(1)	$1,971
Queensland	do	1.6	(1)	(1)	828
Chosen	do	44.7	(1)	(1)	15,640
Mexico	do	(1)	(1)	3.1	4,342
Morocco, French [2]	do	.1	(1)	(1)	4
Norway	do	329	80	157.9	262,000
Peru	do	(1)	(1)	4.6	3,114
United States	do	2,165	84.89	1,103	1,216,000
1933					
Australia:					
New South Wales	do	5.6	(1)	(1)	4,095
Queensland	do	5	(1)	(1)	3,027
Chosen	do	105.2	(1)	(1)	56,070
Mexico	do	(1)	(1)	39.7	60,996
Morocco, French [2]	do	116.5	85	59.4	83,872
Norway	do	414	80	198.7	355,000
Peru	do	6.5	(1)	(1)	(1)
United States	do	4,832.5	88.82	2,574.3	4,252,000
	Wulfenite	19.1	(3)	3	1,800
1934					
Australia:					
New South Wales	Molybdenite	(1)	(1)	(1)	(1)
Queensland	do	(1)	(1)	(1)	(1)
Chosen	do	(1)	(1)	(1)	(1)
Mexico	do	[4] 795	[4] 98	466.8	818,539
Morocco, French [2]	do	150	[4] 85	[4] 76.5	(1)
Norway [2]	do	265.4	80	127.4	219,107
Peru	do	(1)	(1)	(1)	(1)
United States	do	7,913.3	88.98	4,224.6	6,464,000
	Wulfenite	359.2	(3)	21.9	25,000

[1] Data not available.
[2] Exports.
[3] Average content of MoO_3 reported as follows: 1933, 15.97 percent; 1934, 9.13 percent.
[4] Estimated.

China.—In China, Meng and Chang [3] described a molybdenite deposit at Wai-keng-tou where the mineral occurs in a composite quartz vein 3 meters (10 feet) wide and 30 or 40 meters (98 or 131 feet) long. Two other veins on the property are 1 meter thick. Shafts have been sunk 100 feet deep on the first vein. The deposits apparently are of little value.

In the tungsten deposits of Kiangsi a little molybdenite is found in the tungsten-bearing veins. The larger flakes are picked out carefully by the miners, and a few tons of high-grade material are collected each year.

Norway.—Norway has one molybdenite mine, the Knaben, at Fjotland. The company mill was burned early in 1934; concerning this the Mining Journal (London) [4] says:

A fire on Sunday evening last destroyed the dressing plant at the Knaben molybdenite mines in Fjotland, southern Norway, which are situated about 70 km from sea and at an elevation of about 820 m. On the mountain slope there was a huge wooden building covering in the rope-line station, the crushing plant, the four fine ball mills, the mechanical shop, the flotation plant, and the drying room. The fire commenced in the electrically heated drying room, which at once was filled with smoke, thus making it impossible to get the pumps acting. If it had

[3] Meng, H. M., and Chang, K., On the Molybdenite Quartz Veins of Shih-ping Chuan, Tsingtien, Chekiang: Acad. Sinica Nat. Research Inst. Geol., Contributions, no. 4, Shanghai, 1933, pp. 47–57, 1 pl. 2 text figs.
[4] Mining Journal, London (from our own correspondent), Knaben Molybdenite Mill Burnt Down: Vol. 134, Feb. 17, 1934, p. 107.

been on a working day the plant could easily have been saved. Fortunately there was not a strong wind and so the adjoining transformer station was saved and a number of dwelling houses. The mine plant itself is even not affected. The wooden structure with all its valuable machinery was within a few hours completely burnt down. The fire means an immediate stoppage at the mines. About 160 to 170 men were at present employed.

Plans to erect a new dressing mill will be put in hand at once, and it is expected to be ready in 6 months. The insurance is said to amount to 450,000 Kr., distributed among a number of companies.

The fire is a severe blow to our mining industry, and specially in this case, as Knaben is the only mine that for years has been a producer of molybdenum concentrates. This production has been: 1930, 284 tons with 75 percent MoS_2; 1931, 223 tons with 77 percent MoS_2; 1932, 329 tons with 80 percent MoS_2; 1933, 443.5 tons * * *.

The mill was rebuilt during 1934, and an output was made as shown in the table. According to H. K. Smith, mining engineer, of Oslo, official figures showed a content of 0.285 to 0.312 percent MoS_2 in the ore.

METALLURGY

The one new development in the use of molybdenum in 1934 that stands out prominently is the making of high-speed tool steel in which tungsten is largely replaced by molybdenum and the carbon is increased to 0.8 percent or more.[5]

The patent covers steels containing—

C	0.5 to 1.3 percent.
Cr	.2 to 10.0 percent.
Mo	.6 to 15.0 percent.
Si	.1 to 0.45 percent.
W	5 to 40 percent of the Mo, but at least 0.2 percent.
Fe	Remainder.

As advertised, the steel is said to contain—

C	To suit application (apparently about 0.80 percent).
Mo	7.50 to 8.50 percent.
W	1.25 to 2.00 percent.
Cr	3.50 to 4.50 percent.
V	.90 to 1.50 percent.
Mu	.20 to .40 percent.
Si	.25 to .50 percent.

This and other molybdenum high-speed steels are known as Mo-Tung, Hy Mo, MoMax, LMU, etc. How far these steels may replace tungsten high-speed steels is not now apparent. Believers in tungsten high-speed steels admit the competitive value of these alloys, while believers in molybdenum assert that it is only a matter of time until molybdenum wholly replaces tungsten in steels.

Molybdenum is also being used largely in lakes.[6] Just how far it is used as a replacement of tungsten is unknown.

Many details of molybdenum deposits and uses will be found in the Molybdenum chapters of Minerals Yearbooks, 1932–33 and 1934.

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[5] Emmons, Joseph V. (to Cleveland Twist Drill Co.), U. S. Patent 1937334, Nov. 28, 1933.

[6] A lake is an organic coloring matter precipitated from aqueous solution by a metallic salt. Sodium tungstate and sodium molybdate are used in this manner. The precipitates are dried and made into inks both for drawing and for printing.

TUNGSTEN

By Frank L. Hess [1]

SUMMARY OUTLINE

In 1934 the prices for tungsten concentrates, which had risen surprisingly in 1933, continued to soar and remained at a high level. The 1934 prices were the highest known in peace times.

The higher prices were reflected in increased production, as a comparatively small rise above the figure at which tungsten can be produced profitably greatly increases profits. In this respect, of course, tungsten does not differ greatly from many other commodities.

Salient statistics of the tungsten industry in the United States, 1933–34

	1933		1934	
	Short tons	Value	Short tons	Value
Concentrates shipped (60 percent WO_3)	895	$514, 234	2, 049	$1, 791, 316
Imported for consumption (W content)	190	108, 089	477	411, 819
Stocks in bonded warehouses, Dec. 31:				
Ore (W content)	449	214, 194	718	654, 519
Metal (W content)	12	10, 855	14	27, 253

Prices.—Quoted prices in the following table represent world prices and domestic prices, respectively. As London prices for concentrates are quoted for the long-ton unit of 22.4 pounds of tungsten trioxide (WO_3) they are changed to an equivalent price for the short-ton unit of 20 pounds. The values for the British pound are taken from the monthly averages in the Federal Reserve Board Bulletin.

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

London and New York prices for tungsten concentrates and products [1]

Month	Tungsten concentrates: London, 65 percent WO_3: Long-ton unit (22.4 pounds WO_3)	Tungsten concentrates: London, 65 percent WO_3: Equivalent price for short-ton unit (20 pounds WO_3)	Tungsten concentrates: New York, 60 percent WO_3. Short-ton unit (20 pounds WO_3)	Ferrotungsten—per pound of contained tungsten (W): London, 80-percent W standard		Ferrotungsten—per pound of contained tungsten (W): New York 75-percent W standard	Tungsten powder—per pound of contained tungsten (W) (98-percent or more W): London		Tungsten powder—per pound of contained tungsten (W) (98-percent or more W): New York	Sodium tungstate (domestic) C. P. per pound (1,000-pound lots)	Average value of British pound in United States dollars
1933	*s. d.*			*s. d.*			*s. d.*				
Jan	10 3	$1.54	$9.50–$9.85	1 7½	$0.273	$0.94–$1.00	1 10½	$0.315	$1.45		$3.36
Dec	27 4	6.25	14.00–14.75	2 6	.640	1.15– 1.25	2 9	.704	$1.55– 1.75		5.12
1934											
Jan	27 2	6.12	14.50–15.25	2 6	.631	1.15– 1.25	2 9	.694	1.60– 1.75		5.05
Feb	27 4½	6.15	14.50–15.50	2 6	.629	1.25– 1.35	2 9	.692	1.65– 1.85		5.03
Mar	33 10	7.69	15.25–15.50	2 7½	.668	1.25– 1.35	2 10	.721	1.70– 1.85		5.09
Apr	36 4	8.35	16.00–16.25	2 9	.708	1.25– 1.35	3 0	.773	1.70– 1.85		5.15
May	43 6	9.92	17.75–18.50	3 1	.788	1.30– 1.40	3 2	.809	1.75– 1.90	$0.88	5.11
June	43 1	9.71	17.75–18.25	3 3	.821	1.35– 1.45	3 6	.884	1.75– 1.90		5.05
July	40 6	9.11	17.00–17.25	3 3	.819	1.35– 1.45	3 6	.882	1.75– 1.90	.88	5.04
Aug	38 1	8.62	16.50–16.75	3 1	.781	1.35– 1.45	3 4½	.855	1.75– 1.90		5.07
Sept	40 4	8.99	16.50–16.75	3 0	.749	1.35– 1.45	3 3	.811	1.75– 1.90	.88	4.99
Oct	41 4	9.12	16.50	3 0	.741	1.35– 1.45	3 3	.803	1.75– 1.90		4.94
Nov	39 7½	8.83	16.50–16.75	3 0	.749	1.35– 1.45	3 3	.811	1.75– 1.90		4.99
Dec	38 10	8.58	16.50–16.75	3 0	.743	1.35– 1.45	3 3	.804	1.85– 2.00		4.95

[1] All quotations represent weekly averages for each month; London quotations are from the Mining Journal of London and New York quotations from the Engineering and Mining Journal.

Imports.—Domestic supplies of tungsten are inadequate to supply the demand, and the United States imports both tungsten concentrates and products. The imports for consumption of tungsten concentrates and products and the apparent consumption of new tungsten in the United States are shown in the following tables.

Tungsten imported for consumption in the United States, 1933–34

	1933: Pounds	1933: Value	1934: Pounds	1934: Value
Tungsten ore and concentrates (W content)	310,540	$78,222	846,559	$339,634
Tungsten metal and alloys (W content)	68,016	28,466	106,502	69,879
Tungstic acid and other compounds of tungsten, not specially provided for (W content)	779	1,401	705	2,306
	379,335	108,089	953,766	411,819

Apparent consumption of new tungsten in the United States, 1925–34, as shown by imports and production less exports

Year	Supply (contained tungsten—pounds of metal)			Exports of ferrotungsten, tungsten metal, and wire (contained tungsten—pounds of metal, estimated)	Apparent consumption of new tungsten	
	In ore and alloys imported	In domestic ore shipped	Total		Pounds of metal	Equivalent (short tons of 60-percent WO_3 concentrates)
1925	1,693,649	1,133,475	2,827,124	9,930	2,817,194	2,960
1926	2,883,867	1,315,000	4,198,867	23,504	4,175,000	4,387
1927	2,198,051	1,108,000	3,306,051	16,114	3,290,000	3,457
1928	2,968,839	1,150,000	4,118,839	13,313	4,105,000	4,314
1929	6,446,096	790,000	7,236,096	82,257	7,154,000	7,517
1930	3,998,150	668,000	4,666,150	23,983	4,642,000	4,878
1931	189,276	1,336,215	1,525,491	[1] 846,200	679,291	714
1932	106,202	376,881	483,083	[1] 112,626	370,457	389
1933	379,335	851,789	1,231,124	683,130	547,994	576
1934	953,766	1,950,074	2,903,840	563,384	2,340,456	2,459

[1] Of these quantities, in 1931, 802,609 pounds and, in 1932, 90,000 pounds were shipped to U. S. S. R (Russia) as ferrotungsten.

DOMESTIC TUNGSTEN PRODUCTION

The United States increased considerably its production of tungsten concentrates in 1934. Most of the increase was from the established companies with smaller quantities from new, or less active, companies.

Production during the past 10 years is shown in the following table.

Concentrated tungsten ores (reduced to equivalent of 60 percent WO_3) produced in the United States, sold in 1925–34, and average price per unit

Year	Short tons	Value	Average price per unit	Year	Short tons	Value	Average price per unit
1925	1,191	$755,500	$10.57	1930	702	$509,000	$12.09
1926	1,382	920,400	11.10	1931	1,404	928,000	11.02
1927	1,164	724,000	10.37	1932	396	218,394	9.20
1928	1,208	753,900	10.40	1933	895	514,234	9.58
1929	830	654,000	13.13	1934	2,049	1,791,316	14.57

Arizona.—In Arizona the huebnerite placers north of Dragoon, which were among the first tungsten deposits operated in this country, were worked on a small scale by John H. Walker and Yeagley & Knutsen. Water was very scarce, and Mexican laborers extracted the huebnerite by hand-picking the larger pieces and washing out the smaller pieces with rockers. David Taylor and associates attempted to exploit the gravels in Texas Gulch, which drains from the placer area to the San Pedro River, but found them too lean to be profitable.

Huebnerite also was mined in Las Guigas Mountains west of Amado and south of Tucson by the Ore, Metal & Engineering Corporation (Box 2349, Tucson, Ariz.) which leased the property worked a few years ago by North American Mines, Inc., of Boston, and erected a small mill.

A little scheelite was mined from the claims of the Gold, Silver & Tungsten, Inc., in the Huachuca Mountains.

Wolframite was produced by the Boriana Mining Co. from its claims in the Hualpai Mountains 15 miles northeast of Yucca, and the company was the largest tungsten producer in the State. A little wolframite also was produced by lessees of Lawler & Wood from claims at Camp Wood 45 miles west of Prescott by Frank Samsel near Globe, and by D. A. Bessler from the Aquarius Range south of Kingman.

California.—Scheelite was the only tungsten mineral produced in California in 1934. The Atolia Mining Co., whose claims at Atolia about 100 miles north and 35 miles east of Los Angeles were for years the richest known tungsten property in the world, now have little ore in sight, and the mill heads in 1934 were very lean. The inclined shaft on the East Union claim was sunk to 1,400 feet (possibly 1,100 feet vertical depth), and exploratory levels were driven but resulted in no important discoveries. Lessees have furnished ore for the mill from the Spanish mine and from such outcrops as they have discovered.

The Atolia Rand Placers, Inc., has located a large area of placer ground west of the railroad at Atolia, which has received the wash from the gulch running through the Stringer district where a number of small gold mines have been operated. The gulch also crosses the series of scheelite veins mined by the Atolia Mining Co.

The minerals have been carried from both gold veins and scheelite veins by the formerly more plentiful floods, and the placers are being worked for both minerals. The placers on the east side of the railroad carried about 2 pounds of scheelite concentrates (1.4 pounds WO_3 or 1.11 pounds of elemental tungsten) and about 0.01 ounce of gold per cubic yard and were 3 to nearly 50 feet deep.

The placers on the west side of the railroad were discussed in the Mining Review of Salt Lake City for September 4, 1934, page 11, as follows:

> The company is being largely financed by the Molybdenum Corporation of America. The latter company has contracted to purchase the entire output of scheelite at $12.50 per unit. The contract is cancellable on 30 days notice after August 31; it is probable that new arrangements will be made in view of the increased price of tungsten. New finances are being used to erect a plant of 1,200 yards daily capacity, the pilot plant having been only 100 yards per day. Recoveries in this mill were gold, 73 cents; scheelite, 60 cents; total, $1.33, with 59 cents left in tailings, which it is expected will be recovered in the new plant. The proving at present is being done by holes 150 feet apart, some 1,800,000 yards on 59 acres. "Spotted tests of remaining leased property show more than 10,000,000 yards of pay gravel." The new plant is to be ready September 1. Water is to be pumped 7 miles through a 4-inch pipe. Since March 31, the pilot plant produced and marketed gold and scheelite valued over $4,000. Property is about 7 miles from Randsburg, California. The office of the company is located in the Chester Williams Building, room 506, Los Angeles, California.

Gravel is hauled to the new portable mill in autotrucks, and after the new gravel is dumped a load of washed gravel is taken on and hauled to the pits from which it was dug, thus disposing of tailings. The water for washing is pumped from a well in Cuddeback Lake, a playa in which water collects in wet seasons but which is dry most of the time. The water is too alkaline for household use, and drinking water is obtained from the Randsburg supply at the price in force for many years—1 cent per gallon.

The Tonopah Mining Co. sold a small lot of scheelite concentrates that it made several years ago from the tactite deposits in Round Valley near Bishop, Inyo County.

Colorado.—In the Boulder field nearly all of the mining was done by lessees. The Wolf Tongue Mining Co. and the Gold, Silver & Tungsten, Inc. (formerly the Tungsten Production Co., Inc.), leased to miners and bought and milled the ore produced. Lessees on other tracts also produced considerable ore.

The most successful lessees seem to have been Henderson, McKenzie & Walsh on the Tanner tract on Beaver Creek south of Nederland.

A small lot of huebnerite was shipped by Las Animas Development Co. from Silverton and another small lot by J. M. Belisle from Ophir Loop near Ophir.

Idaho.—The Ima Mines Corporation (May, Idaho) took over the claims of the Ima Consolidated Mines & Milling Co., Salt Lake City, covering the huebnerite-bearing quartz vein on Patterson Creek, Idaho, and shipped 2,300 pounds of concentrates carrying 56 percent WO_3. Most of the corporation's effort was spent in cleaning up tunnels and sinking a 300-foot winze. The ore is said to carry about 1 percent WO_3 and 10 ounces of silver per ton. It was planned to mill 60 tons of ore per day during 1935 and to float both huebnerite and sulphides.

The Four Square Gold Syndicate at Wallace reports having a small percentage of scheelite in its ore, but no production has been made.

Montana.—The Jardine Mining Co. treated some tungsten tailings, but no concentrates were shipped.

Nevada.—Nevada has many known tungsten deposits, most of which are lean. On the other hand, the mine of the Nevada-Massachusetts Co. near Mill City is at present the largest producer of tungsten in this country. The ore is scheelite found in tactite, and although the limestone beds are only 3 to 6 feet thick they are of extraordinary continuity and have been followed downward more than 900 feet.

The deposits have been described by Prof. Paul F. Kerr in a paper entitled "Geology of the Tungsten Deposits near Mill City, Nev.", published by the University of Nevada. (Bull. 2, vol. 28, 1934, 46 pp.) The bulletin is well-illustrated with maps, plans, and photoreproductions.

During the year the Nevada-Massachusetts Co. acquired a scheelite deposit recently discovered by Gordon and Marker near Oreana. The ore bodies are related closely to pegmatite. The vein contains white feldspar, green beryl, quartz, and some mica with grayish or white scheelite. A paper on this deposit by Professor Kerr is in course of publication. Development work by the company was carried on throughout the year on its vein deposit, the Silver Dyke, in the mountains west of Mina.

Gold, Silver & Tungsten, Inc., produced some scheelite from its tactite deposit on the east side of the Nightingale Mountains.

The Moulton-Vogelaar Syndicate (Ely) sunk a shallow shaft on its scheelite property on the west side of the Snake Range 40 miles southeast of Ely but made no concentrates. J. S. Deardon (Baker) shipped a small quantity of scheelite from the east side of the range.

New Mexico.—R. H. Sipple, White Oaks, shipped a small amount of huebnerite from a newly discovered vein.

Washington.—James Keeth (East 1827 Sprague Avenue, Spokane) shipped a small quantity of high-grade wolframite concentrates from the Spokane Indian Reservation. The mineral occurs in quartz veins.

The Tungsten Co. of America at Goose Prairie, Yakima County, did some work on a vein carrying sheelite with chalcopyrite, molybdenite, and pyrite, but no ore was shipped.

Tungsten Producers, Inc. (Fruitland), mining the wolframite-bearing quartz veins long ago worked by the Germania Mining Co. at Deer Trail just north of the Spokane Indian Reservation, made the largest shipments ever recorded for the mine in 1 year—139 tons carrying 70 percent WO_3 (equivalent to 162 tons of 60 percent WO_3). The company held 35.5 tons in stock at the end of the year.

WORLD PRODUCTION

The higher tungsten quotations during the year caused increased output in most of the foreign producing countries.

A review of the year indicates that the cheaply mined tungsten ores are exhausted, and costs of mining hereafter probably will be higher.

The available figures for the world production of tungsten ores (given in metric tons—other weights in this article are in short tons) are shown in the following table.

World production of tungsten ore, 1930–34, in metric tons of concentrates containing 60 percent WO_3

[Compiled by L. M. Jones, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
North America:					
Mexico	28				80
United States	637	1,274	359	812	1,859
	665	1,274	359	812	1,939
South America:					
Argentina	98	20	6		(2)
Bolivia [3]	888	410	686	240	(2)
	986	430	692	240	(2)
Europe:					
Czechoslovakia	74	17			(2)
Germany (Saxony)		5			(2)
Great Britain (Cornwall)	153	121	2	12	(2)
Portugal	499	274	272	358	608
Spain	254	135	43	46	(2)
	980	552	317	416	(2)
Asia:					
China [3]	9,454	7,492	2,249	6,000	5,098
Chosen	13	17	62	144	(2)
India (Burma)	2,699	2,474	2,226	2,524	[3] 4,000
Indo-China (Tonkin)	220	248	247	233	(2)
Japan	81	56	22	31	(2)
Malay States:					
Federated Malay States	1,054	462	378	1,188	1,695
Unfederated Malay States	178	241	175	91	(2)
Netherland India	15	1			(2)
Siam	7	12			(2)
	13,721	11,003	5,359	10,211	(2)
Africa:					
Southern Rhodesia	38	24	14	33	117
South-West Africa				3	18
Union of South Africa		2			
	38	26	14	36	135
Oceania:					
Australia:					
New South Wales	17	62	27	(4)	(2)
Northern territory:					
Central Australia	67	} 29	15	13	(2)
North Australia	(4)				
Queensland	24	3	8	14	(2)
Tasmania	133	(4)		123	(2)
New Zealand [3]	21	6	9	19	(2)
	262	100	59	169	(2)
	16,700	13,400	6,800	11,900	(2)

[1] In addition to the countries listed, tungsten ore is produced in the U. S. S. R. (Russia), but no data of production are available for the period under discussion.
[2] Data not available.
[3] Exports.
[4] Less than 1 ton.

Burma.—All tungsten ore from Burma is shipped through Rangoon. As shipments are not segregated there is no way of determining whether they are from Lower Burma or Mawchi. The Mawchi concentrates ordinarily carry 43 percent wolframite concentrates (69 percent WO_3) and 57 percent cassiterite and are shipped to Murex, Ltd., London, England, for magnetic separation. The concentrates from Lower Burma (Tavoy and Mergui) are separated at Tavoy where Consolidated Tin Mines of Burma, Ltd., has an electromagnetic separation plant which raises the concentrates to about 69 percent WO_3.

Shipments of tungsten concentrates from Rangoon, 1930–34 [2]

Year	Long tons	Year	Long tons
1930	3,260	1933	3,874
1931	4,463	1934	5,239
1932	3,397		

China.—For almost 20 years China has been the principal producer of tungsten. However, shipments of concentrates from this country in 1934 were less than those in 1933.

The figures on exports, obtained by Charles A. Robertson of the American Consulate in Canton, are as follows:

Destination of tungsten ore shipped from China, 1933–34

Destination	1933		1934	
	Pounds	Value	Pounds	Value
Belgium	(1)	(1)	1,080,694	$248,166
France	(1)	(1)	1,265,662	271,601
Germany	2,762,260	$216,005	3,274,933	673,636
Great Britain	123,200	5,244	1,412,928	273,049
Hong Kong	6,082,785	466,367	443,786	82,683
Italy	895,331	56,219	55,997	9,872
United States	313,599	20,986	2,613,333	531,892
Other countries	2,034,795	157,373	228,617	62,237
Total	12,211,970	922,194	10,375,950	2,153,136

1 Included in "Other countries."

For a number of years the Provincial Government of Kiangsi, in which most of the tungsten deposits are found, and the National Government have tried to obtain a monopoly of tungsten mining without success. The Canton Government finally took over the policing of Kiangsi and monopolized the Kiangsi ores. The largest field, at Si-wah Shan, is in the southwest corner near both Hunan and Kwangsi. Ores were smuggled into Hunan and thence to Shanghai, also down the East River to Hong Kong. The Canton Government found trouble in paying the miners and selling on consignment, but ores from other countries, particularly Burma and Bolivia, undoubtedly cut into the European market, and at the end of the year it seemed that the Chinese monopoly must collapse.

Malay States.—The production of the Malay States increased about 50 percent, apparently from the Kramat Pulai scheelite mine in the village bearing the same name 7 miles east of Ipoh, Perak.

2 Figures from Bureau of Foreign and Domestic Commerce.

Other countries.—Interest in tungsten mining also increased in Australia and Portugal. Southern Rhodesia, always a small producer, is reported to have produced 118.5 short tons of scheelite concentrates.[3]

TECHNOLOGY

Among the outstanding recent events in the technology of tungsten is the placing on the market of "Motung", a high-speed steel in which all but about 2 percent of the tungsten is replaced by molybdenum and the carbon is increased to 0.8 or more percent.[4] The patent covers the following percentages of constituents: C, 0.5 to 1.3; Cr, 0.2 to 10.0; Mo, 0.6 to 15.0; Si, 0.1 to 0.45; and W in proportion of about 5 to 40 percent of the amount of the Mo present (with at least 0.2 percent W).

A number of tool-steel companies have taken out licenses to manufacture the steel.

Tungsten adherents claim that a tungsten steel containing as much carbon as Motung, especially if the tungsten is raised to 19 or 20 percent, is a better steel, but that the higher carbon content tends to make both steels brittle.

It is too early to form a definite opinion of the comparative merits of the steels, but it seems certain that when tungsten prices are high Motung is a substitute for tungsten high-speed tool steel.

[3] Mining Journal (London), Southern Rhodesia: Vol. 187, Mar. 9, 1935, p. 171.
[4] Emmons, Joseph V. (to Cleveland Twist Drill Co.), United States Patent 1937334, Nov. 28, 1933.

TIN

By Charles White Merrill

SUMMARY OUTLINE

Tin is the most valuable mineral product that the United States must obtain almost exclusively by importation. Imports in 1934 were valued at nearly $45,000,000, but domestic mine output was worth less than $10,000. Maintenance of an uninterrupted flow of tin into the United States is imperative because it is indispensable to two of the largest domestic industries—automobile manufacture and food packing.

United States production.—The domestic output of tin in 1934 was 8.2 long tons, valued at $9,600; most of it was mined in Alaska. However, recovery of secondary tin—that is, production of tin from sources other than ore—provided over one third of the United States supply.

Salient statistics for tin in the United States, 1925–34

	1925–29 average	1930	1931	1932	1933	1934
Production:						
From domestic mines ... long tons	24	15	3.7	0.4	[1] 2.7	8.2
From secondary sources ... do	30,598	23,393	17,679	13,170	19,732	22,232
Imports for consumption ... do	78,009	80,734	66,064	34,819	63,718	39,986
Exports (domestic and foreign) ... do	1,740	2,233	[2] 1,661	[2] 1,116	[2] 1,041	[2] 1,216
Monthly price of Straits tin at New York:						
Highest ... cents per pound	70.67	38.91	27.07	24.76	53.07	55.60
Lowest ... do	39.79	25.27	21.35	19.24	22.70	50.87
Average ... do	56.64	31.70	24.46	22.01	39.12	52.16

[1] Revised figures.
[2] Foreign only. Domestic not separately recorded.

United States consumption.—The bulk of the tin consumption in the United States depends upon relatively few industries, notably food packing, automobile manufacture, and building. Food packing is relatively stable from year to year and may be counted upon to absorb a fairly constant quantity of tin plate and solder. The automobile industry continued to improve, although its output was still below

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normal, and further recovery was widely prophesied for 1935. The general depression still was felt acutely in the building trades, which are large users of terneplate, tin plate, solder, and a variety of other tin-bearing articles employed in equipping new buildings.

World output, price, and stocks.—The world production of tin (tin content of ores) in 1934 was 117,000 long tons, an increase of 30 percent from the 90,000 tons produced in 1933, but 39 percent below the 193,000 tons produced in the record year 1929. Thus for the first time since 1929 there was an annual increase in world output. The production of the four leading tin-mining countries was 84,515 tons (72 percent of the world total), as follows: Federated Malay States, 36,385 tons (31 percent); Bolivia, 20,634 (17 percent); Netherland India, 17,339 (15 percent); and Siam, 10,157 (9 percent). The smelter production of tin was even more localized than the mine output, as the four leading tin-smelting countries—the Straits Settlements, the United Kingdom, Netherland India, and the Netherlands—produced approximately nine tenths of the world total.

The principal supply to consumers in the United States is imported into the domestic market as refined pig tin, and most of it comes from two countries; the Straits Settlements furnished 62 percent and the United Kingdom 21 percent of the 1934 total. Imports of tin for consumption in 1934 were 39,986 long tons, a decrease of 37 percent from the 63,718 tons imported in 1933. However, there was a decrease of only 13 percent in value—from $51,240,829 in 1933 to $44,800,650 in 1934.

The average price of Straits tin at New York was 52.16 cents a pound for 1934 compared with 39.12 cents for 1933 and 22.01 cents for 1932. Thus the devaluation of the dollar, the international production-curtailment program, and the improvement in tin-consuming industries in the United States combined to raise the price of tin well above the average of 45.19 cents for 1929.

The decline in world "visible" stocks (in Government warehouses and in transit) that started in the middle of 1932 continued throughout 1933 and 1934. From an all-time high of 51,707 long tons at the end of July 1931 the stocks remained virtually static until the end of May 1932, decreased to 23,812 tons at the close of 1933, and fell to 13,698 tons at the close of 1934, the lowest point since the end of August 1926. If tin consumption were at its normal level, this 13,698 tons would be near the minimum required for stocks in transit between smelter and consumer, but in the present state of diminished consumption they are more than ample. Moreover, the secretly held stocks of the Buffer Pool also have been available.

The accompanying graph (see fig. 32) illustrates some of the salient features of the tin industry since 1900. During most of this period world mine production follows an upward slope of lower inclination than that of many other metals. The effects of the post-World War depression and the boom of the late twenties are clearly seen. In 1933 production sank below that for any year since 1902. The most significant feature of the graph, however, is the parallelism between the price curve and the United States tin-imports curve. Bearing in mind the general industrial trend over the period, the importance to tin miners of industrial activity in the United States can be seen at a glance. The curve for prices shows a strong tendency to fall as world visible stocks increase and vice versa; United States visible stocks, although so small as to be almost insignificant, parallel the course of world visible stocks to some extent.

International production control.—The high tin prices of 1926–27 caused a boom in the development of tin mines that led to overproduction of tin as early as 1928. Stocks began to rise and prices to fall. During the summer of 1928 the Tin Producers' Association was formed to regulate the output of tin mines, but the general industrial depression caused a decline in consumption that nullified all benefits from controlled production. In 1930 a move was started to effect a legally enforceable curtailment program.

The governments of British Malaya, Bolivia, Netherland India, and Nigeria finally agreed to a production-control plan that went into effect March 1, 1931. The organization for carrying out these plans was called the International Tin Committee and had its headquarters at The Hague. The committee assigned an export quota to each of the four participating countries, with the understanding that

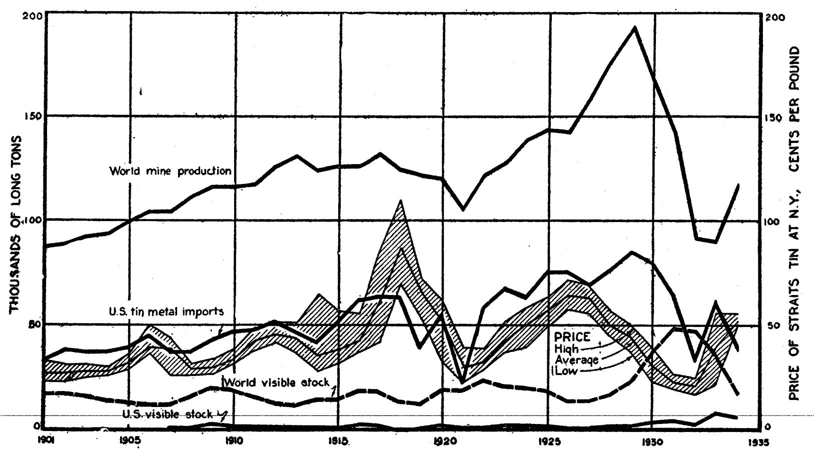

FIGURE 32.—Trends in production, imports, stocks, and prices of tin, 1901–34.

each would translate its quota into controlled production by assigning output quotas to its several producers. Each Government, supported by the necessary legislation, issued individual production permits; disregard of these made offenders subject to heavy penalties. Siam joined the plan later on a basis of accepting an annual quota of 10,000 long tons effective from September 1, 1931. The original four countries subsequently accepted several reductions in their quotas, until they were reduced to one third of their 1929 rate of production for the period July 1, 1932, to December 31, 1933. Acceptance of this final reduction may be said to have been the turning point in the fortunes of the tin industry, because the date of its application roughly coincides with the high point in visible stocks and the low point in price (gold) of tin. Recovery, however, was slow until the spring of 1933, but since then the increase in consumption and reduction in stocks have made it possible to increase quotas.

Negotiations were begun in 1933 to extend the production-control plan beyond August 31, 1934, its expiration date. A new agreement was finally accepted, to run for 3 years from January 1, 1934, with the basis for computing quotas slightly revised. During the first and last quarters of 1934 the quota for the original four signatory countries was set at 40 percent, but during the intervening 6 months it was raised to 50 percent. In addition, these four countries distributed among themselves an added 4-percent quota to adjust past irregularities; furthermore, they were awarded a special quota on June 1, 1934, to supply the Buffer Pool with 8,282 long tons of tin before the end of the year. Thus in 1934 they produced at 54 percent of the 1929 rate of output.

At the July meeting of the International Tin Committee it was announced that the Belgian Congo, Indo-China, the United Kingdom (Cornwall), and Portugal had been induced to join the output-restriction scheme. The terms under which they joined, however, were so liberal that little if any curtailment will result. The table on page 516 summarizes the quota data.

The Buffer Pool was proposed in the fall of 1933 but was received with most severe criticism by brokers, speculators, and many producers who held that market stabilization could be promoted more successfully by frequent adjustment of quotas. Proponents of the pool prevailed, however; the International Tin Committee announced the terms of the pool agreement on June 5, 1934, and it was officially signed by the representatives of the four participating countries on July 10, 1934, at The Hague. The International Tin Committee was given full control of the tin in the pool and of the proceeds derived from selling any of it. The agreement runs to the end of 1935.

One of the original objectives of the Tin Producers' Association was to provide the tin industry as a whole with better statistics and with a research organization. During 1933 this program began to yield results. The International Tin Research and Development Council's statistical office at The Hague is now publishing comprehensive data on the tin industry. The council also is cooperating with the United States Tin Research and Development Committee of the American Tin Trade Association and has placed the actual research work with the Battelle Memorial Institute, Columbus, Ohio. The committee proposes to expand the present uses of tin, develop new uses, and preserve and strengthen existing markets where tin meets competition.

The interests of tin consumers were recognized at last by the restrictionists when the Consumers' Advisory Panel was set up in October 1934. It was announced that John Hughes would be invited to represent the United States consumers. It appeared, however, that this panel was no more than a friendly gesture, as the members of the panel were given no vote in shaping the committee policy.

New criticism was directed at the cartelization of the tin-mining industry when some of the speculators exposed by the collapse of the pepper and shellac markets at London in February 1935 proved to be leading figures in the tin production-control scheme. The situation was debated [1] in the House of Commons, where the Government defended the part it had played in the production-control plan and the tin pools supplementary to it.

Congressional Tin-Investigation Committee.—Those interested in an unrestricted flow of tin in international trade have felt for a long time that the United States should investigate all possible methods of

[1] The Metal Bulletin, Tin in Parliament: No. 1973, Mar. 12, 1935, p. 10.

protecting itself against extortionate prices in peace time and shortage of this strategic metal in war time. Their efforts bore fruit during 1934, when the House of Representatives started hearings on the tin situation. The hearings were opened by the Tin Investigation Committee of the Committee on Foreign Affairs. Representatives Sam D. McReynolds, chairman, and Millard F. Caldwell of the committee, and H. H. Buckman, its investigator, directed the proceedings.

Witnesses were called to testify as to the interests of various tin-consuming industries, metal brokers, smelters, American owners of foreign tin mines, promoters of domestic tin properties, detinners, and scrap-metal dealers. The Bureau of Mines, the Bureau of Foreign and Domestic Commerce, the Geological Survey, the Bureau of Standards, the State Department, the War Department, and the Navy Department all sent specialists for questioning before the committee.

The testimony brought out a great many possible courses which could be taken by the United States to improve its present position with respect to tin. The possibility of establishing a domestic tin-mining industry was investigated at some length, and suggestions were advanced that a Nation-wide geological survey aimed at the discovery of tin deposits be conducted and that direct Government aid be granted to develop particular properties. Protection to the secondary tin industry was considered in the form of embargoes on the exportation of scrap from which it derives its tin. A great deal of testimony centered about the possibility of reestablishing a domestic tin-smelting industry. Sources of ore and concentrates and their control were suggested for intensive study; United States costs were compared with those of the United Kingdom; and the effectiveness of a tariff on tin metal with tin ore and concentrates remaining on the free list was discussed. The military and naval requirements were considered at some length, and this led to considerable testimony with respect to the effects of a large Government-owned stock pile of the metal. Another line of defense for domestic consumers is the use of substitutes. Testimony was taken regarding the possibilities of developing substitutes and the subsidy of research for such work.

Although the committee has not completed its investigation it is expected that it soon will be ready to present recommendations regarding this complex problem in the form of a bill.[2] An interesting analysis of the situation has been made by R. S. McBride and published as The Tin Problem in the United States, pages 170 to 173 of the April 1935 issue of the Engineering and Mining Journal.

Resistance to the monopolistic tendencies of the tin restrictionists has not been confined to United States consumers by any means. Many producers in the restricting countries as well as brokers and others interested in the tin business have expressed themselves as opposing the cartel. J. K. Eastman of the School of Economics and Politics voiced [3] a widely held opinion regarding restriction in the following quotation:

> I interpret the tin-control scheme as an attempt by those who have invested capital in ways which events have proved mistaken to restore the value of their

[2] The McReynolds bill (H.R. 7675) was introduced in the House of Representatives on Apr. 23, 1935, and referred to the Committee on Ways and Means.

[3] The Mining Journal (London), Future Problems in the Development of Tin Control: Vol. 184, no. 5175, Oct. 27, 1934, pp. 796–799.

property. Two considerations would appear to make this impossible. First of all, it seems probable that a major change in prices has taken place. If the price of one commodity is restored to the predepression level while other commodity prices remain at lower levels, elasticities of substitution are likely to be very much greater than they were formerly. The demand for tin may still remain inelastic, but the demand curve will move so drastically to the left that demand will be reduced. Further, substitution may take place not by the simple replacement of tin by some other commodity but by the adoption of entirely new ways of doing tasks tin now helps to perform. This would involve changes in the fixed equipment of industries which are now tin consumers, and once this change was made a drastic and prolonged depression of tin prices would be necessary to reinstate tin in its old uses.

The second consideration is the stimulus that will be given to production outside the scope of the control scheme. The proportion of capacity uncontrolled is now too small for the danger to be immediate, but if those who want a permanent scheme succeed in securing a further extension beyond 1936 the danger will be real enough. There are already signs that the tin trusts are willing to bid up the prices of prospected concessions to prevent them falling into the hands of persons who are antagonistic to restriction, but this can hardly prevent competition in the long run. It is, however, an interesting example of the way in which the costs of maintaining a monopoly can reduce the return to capital below that obtaining in competitive industry.

The higher tin prices have renewed prospecting and development in stanniferous areas throughout the world, particularly in countries not parties to the production-restriction plan. Although the new production resulting from these activities has not yet greatly affected the world tin market it already is causing grave anxiety to the International Tin Committee. From the standpoint of the consumer these new developments should prove very beneficial in future.

DOMESTIC PRODUCTION AND RESOURCES

Primary tin.—Although the United States has never been an important producer of tin, it does not lack producing deposits entirely; nevertheless, careful studies of areas where tin has been produced or where it has been found, particularly during the World War period, indicate that this country cannot expect to supply even an appreciable part of its requirements. The following table gives the domestic mine production for the past 10 years; no smelter production has been reported since 1924.

Mine production of recoverable tin in the United States (including Alaska), 1925–34

Year	Long tons	Value	Year	Long tons	Value
1925–29 (average)	24.0	$28,800	1932	0.4	$220
1930	15.0	10,500	1933	[1] 2.7	[1] 2,400
1931	3.7	2,050	1934	8.2	9,600

[1] Revised figures.

Alaska has been the chief source of tin for many years and produced 8 long tons in 1934. South Dakota produced the remaining 0.2 ton. No other production was reported, but areas in North Carolina, California, Virginia, South Carolina, and Texas have produced small quantities in the past, and tin minerals are known to occur in many other States. In a report [4] by the Geological Survey on the tin occurrences in Alabama E. W. Ellsworth states:

[4] Ellsworth, E. W., Tin Deposits of Alabama: Memorandum for the press, P. W. 20674, Department of the Interior, 1934, 13 pp.

In conclusion it can be stated that the deposits of tin examined do not appear to contain sufficient tin to warrant commercial exploitation. Whether prospecting for tin in Alabama in the future will reveal workable tin deposits is altogether problematic.

Secondary tin.—During 1934, 22,232 long tons of secondary tin were recovered in the United States, an increase of 13 percent from that recovered in 1933 and equivalent to 56 percent of the virgin tin imported in 1934. If the recovery of secondary tin were included with primary production the United States would rank second among tin-producing countries.

Tin content and value of secondary tin recovered in the United States, 1925–34 [1]

Year	Recovered at detinning plants			Recovered from all sources			
	As metal (long tons)	As chemicals (long tons)	Total (long tons)	As metal (long tons)	As alloys and chemicals (long tons)	Total: Long tons	Total: Value
1925–29 (average)	891	2,021	2,912	7,518	23,080	30,598	$38,034,120
1930	1,032	2,310	3,342	5,000	18,393	23,393	16,228,300
1931	985	1,912	2,897	4,911	12,768	17,679	9,428,800
1932	628	1,579	2,207	4,152	9,018	13,170	6,248,100
1933	838	1,792	2,630	6,473	13,259	19,732	16,508,700
1934	940	1,761	2,701	7,366	14,866	22,232	25,487,600

[1] Figures compiled by J. P. Dunlop, of the Bureau of Mines.

The principal uses of tin are in conjunction with steel as in tin plate, with lead as in solder and babbitt, and with copper as in bronze. Consequently the recovery of tin from scrap and junk depends on the market for these metals as well as that for the reclaimed tin itself. Industrial activity also affects secondary tin output by determining the quantity of scrap available. Most tin recovered from alloys does not pass through a refined-tin stage but is used in making alloys which are brought to required specifications by adding virgin metals.

The most important single source of secondary tin is tin-plate scrap, which is detinned for its steel as well as its tin. During the last 2 years domestic detinners have met increasing competition from Japanese buyers for tin-plate clippings produced at seaboard points. The Japanese detinners have an advantage over domestic buyers because Japan's tin import duty does not apply to the tin content of tin-plate scrap. Consequently the Japanese detinners enjoy a premium on the tin they reclaim equal to their country's import duty on pig tin. The Faddis bill passed in the Seventy-third Congress provided for an embargo on the exportation of tin-bearing scrap at the discretion of the Secretary of War. It was not signed by the President, but it is understood that its principal provisions will be incorporated in the bill being drafted by the Tin Investigation Committee.

IMPORTS AND EXPORTS [5]

Metal and ore.—Imported tin concentrates first were smelted in the United States in 1916, following the first imports in 1915. These imports reached the high point in both quantity and value (30,489 long tons, $18,795,162) in 1920 but have been negligible since 1923.

[5] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Foreign trade of the United States in tin and tin concentrates, 1925–34

Year	Imports				Exports of metallic tin (long tons)	
	Metallic tin [1]		Tin concentrates [2]			
	Long tons	Value	Tin content (long tons)	Value	Domestic [3]	Foreign [4]
1925–29 (average)	78,009	$95,920,333	175	$100,162	637	1,103
1930	80,734	60,233,644	289	177,120	84	2,149
1931	66,064	36,723,656	30	7,117	(5)	1,661
1932	34,819	16,473,998	17	4,364	(5)	1,116
1933	63,718	51,240,829	24	10,630	(5)	1,041
1934	39,986	44,800,650	[2] 2	[2] 859	(5)	1,216

[1] Imports for consumption.
[2] Data on total imports during 1934 may not be strictly comparable with figures for previous years, due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports", whereas totals for 1934 represent "imports for consumption."
[3] Imported as ore and exported as pigs, bars, etc.
[4] Imported as pigs, bars, etc., and exported as such.
[5] Not separately recorded.

In 1934, 39,986 long tons of tin (bars, pigs, blocks, grains, and granulated) were imported for consumption into the United States compared with 63,718 tons in 1933 and 34,819 in 1932. The Straits Settlements supplied 62 percent of the tin imported in 1934, the United Kingdom 21 percent, and all others 17 percent; in 1933 the Straits Settlements furnished only 50 percent while the United Kingdom supplied 33 percent. Prior to 1933, however, the Straits Settlements' proportion was considerably greater than in 1934.

During 1934 the proportion of English refined tin in the United States imports declined sharply. Straits tin regained some of the ground lost since 1931, when it accounted for three quarters of the imports, and the importance of Banka and the Chinese brands continued to advance.

Metallic tin (bars, pigs, blocks, grains, and granulated), imported into the United States, 1933–34, by countries [1]

Country	1933		1934 [1]	
	Long tons	Value	Long tons	Value
Australia	170	$142,662	48	$51,418
Belgian Congo	50	49,869	277	322,042
Belgium	75	63,234		
Canada	42	18,592	29	10,074
China	2,001	1,378,168	1,459	1,559,917
Germany	1,516	796,776	945	591,992
Hong Kong	1,982	1,402,363	1,394	1,541,640
Malaya (British) (Straits Settlements)	31,621	24,093,380	24,829	28,031,345
Netherlands	3,203	2,524,216	815	978,641
Netherland India	1,278	1,060,067	1,722	1,965,742
New Zealand	(2)	66		
Panama			1	382
United Kingdom	20,904	19,658,999	8,467	9,747,457
	62,842	51,188,392	39,986	44,800,650

[1] Data on total imports during 1934 may not be strictly comparable with figures for previous years, due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports", whereas totals for 1934 represent "imports for consumption."
[2] Less than 1 ton.

Exports of metallic tin continued small; tin exported in the form in which it was imported increased from 1,041 in 1933 to 1,216 tons in 1934.

Tin manufactures.—Imports of tin plate, terneplate, and taggers tin were 126 long tons valued at $31,821 in 1934 compared with 261 tons valued at $40,185 in 1933. In 1934 the United Kingdom furnished four-fifths of the tin-plate imports.

The exports of tin plate, terneplate, and taggers tin totaled 184,299 long tons valued at $16,846,720 for 1934 compared with 95,239 long tons valued at $7,650,419 for 1933, an increase of 94 percent in quantity and 120 percent in value. The world export market for tin plate expanded between 5 and 10 percent during 1934, but the exports of the United Kingdom, the largest exporter, declined almost 15 percent. The United States made by far the greatest gains both in quantity of tin plate and proportion of the total market, but substantial gains also were recorded for Germany, France, and Italy. Even keener competition is foreseen in future as machinery now being installed in Japan promises to add that country to the list of tin-plate exporters within a short time.

During July 1934, an agreement was signed by the principal tin-plate manufacturers of the world for regulation of international trade in their product. A schedule of minimum prices was fixed, and it was reported that the market was provisionally divided as follows: Wales, 55 percent; United States, 22 percent; Germany, 16 percent; and Italy and France, the remaining 7 percent. This division of the market represents a small increase for the United Kingdom and a small decrease for each of the other producers compared with 1934. Until 1930, however, the Welsh manufacturers supplied 75 percent or more of this export market. The success of the cartel appears to depend on whether or not the higher prices for tin plate will stimulate production unduly in countries outside the cartel's influence. Norway is reported to have joined the plan later.

Tin plate, terneplate, and taggers tin exported from the United States, 1925–34

Year	Long tons	Value	Year	Long tons	Value
1925–29 (average)	234,932	$26,265,495	1932	39,603	$3,272,566
1930	216,516	24,201,977	1933	95,239	7,650,419
1931	84,433	7,841,193	1934	184,299	16,846,720

During 1934 approximately one-half of the United States tin-plate exports went to the Orient, where Japan and China were the principal customers; South American countries accounted for over a quarter of the exports, Argentina, Brazil and Uruguay being the largest customers there. Most of the tin plate was exported through the Maryland and New York port districts; the former port accounted for almost twice as much as the latter.

Exports of tin plate, terneplate, and taggers tin from the United States, by principal countries and districts, 1933–34

	1933		1934	
	Long tons	Value	Long tons	Value
Country				
Argentina	9,668	$776,328	20,095	$1,870,581
Brazil	3,215	259,276	11,428	1,086,751
British Malaya	1,294	100,415	3,420	301,354
Canada	2,177	187,749	2,784	272,214
Chile	934	85,516	3,381	327,452
China	14,326	1,174,169	24,162	2,212,438
Colombia	1,237	107,792	2,886	283,677
Cuba	3,162	243,786	5,840	570,226
Greece	334	24,725	3,400	295,051
Hong Kong	5,970	450,146	5,471	484,764
Japan	23,943	1,924,639	39,864	3,602,471
Kwantung	3,632	273,998	5,471	477,570
Mexico	3,334	301,551	9,939	929,006
Netherland India	6,487	491,849	3,645	327,267
Peru	376	33,149	4,055	364,855
Philippine Islands	6,406	516,639	8,684	776,112
Sweden	990	76,601	4,158	337,760
Syria	591	45,374	3,404	290,189
Turkey in Asia and in Europe	939	72,608	3,176	276,485
Uruguay	2,014	160,533	7,401	686,563
Others [1]	4,210	343,576	11,635	1,073,934
Total	95,239	7,650,419	184,299	16,846,720
District				
Maryland	60,685	4,805,202	112,065	10,186,970
New York	29,962	2,439,174	64,939	5,965,140
Others [1]	4,592	406,043	7,295	694,610
Total	95,239	7,650,419	184,299	16,846,720

[1] Includes all exports not exceeding $250,000 in 1933 or 1934.

Much tin also is exported from the United States in manufactures, little of whose value is derived from the tin they have consumed incident to production. The most important of such exports are products of the automotive and the food-packing industries. There are no statistics on the quantity of tin thus exported, but estimates based on the total exports of these products indicate that it is considerable.

CONSUMPTION AND USES

The United States is the world's leading consumer of tin, due largely to its supremacy in the canning and motor-vehicle industries. The Bureau of Mines canvassed the domestic tin-consuming industries to ascertain their annual consumption and stocks of virgin tin in 1927, 1928, and 1930.[6] The results of this work are presented in the following table. As the earlier estimates of the War Industries Board (1917) and the Bureau of Mines (1925)[7] include secondary tin they are not comparable with the following figures.

[6] Umhau, J. B., Consumption of Primary Tin in the United States During 1930: Inf. Circ. 6564, Bureau of Mines, 1932, 7 pp.
[7] Furness, J. W., Consumption of Tin in the United States, 1925: Inf. Circ. 6019, Bureau of Mines, 1927, 3 pp.

Virgin tin consumed in the United States, 1927, 1928, and 1930, by uses

Use	1927		1928		1930	
	Long tons	Percent of total	Long tons	Percent of total	Long tons	Percent of total
Tin plate and terneplate	24,525	35.96	27,053	36.38	27,753	42.40
Solder	13,602	19.94	13,874	18.66	11,407	17.43
Babbitt	7,595	11.14	8,150	10.96	5,438	8.31
Bronze	4,664	6.84	4,324	5.81	3,499	5.35
Foil	4,193	6.15	5,068	6.81	3,061	4.68
Collapsible tubes	2,710	3.97	2,864	3.85	[1] 3,826	5.84
Chemicals	2,621	3.84	4,246	5.71	3,268	4.99
Tin oxide	1,311	1.92	1,183	1.59	666	1.02
Tinning (brass, copper tubes, sheets, shells, wire, nails, etc.)	2,661	3.90	2,636	3.54	2,814	4.30
White metal	849	1.25	802	1.08	1,117	1.71
Type metal	450	.66	411	.55	223	.34
Castings	1,011	1.48	730	.98	[2] 74	.11
Other alloys	556	.82	629	.85	306	.47
Miscellaneous	1,450	2.13	2,399	3.23	1,996	3.05
	68,198	100.00	74,369	100.00	65,448	100.00

[1] Not comparable with preceding years owing to the canvassing of several additional users whose consumption was not included previously.
[2] Pure tin castings only; in preceding years some tin-alloy castings were reported under this heading.

Virgin-tin consumption can be estimated from the figures for mine production, imports, exports, and stocks; the result is termed "apparent" consumption. Apparent consumption is only an approximation of actual consumption, because it does not take full account of "invisible" stocks and because secondary tin may be included in the figures used for stocks. In the United States in 1934 the apparent consumption of virgin tin was 43,638 long tons, a 27-percent decline from the 59,693 tons in 1933. Moreover, the 1934 figure was only 57 percent of the 5-year average ending with 1929. Since 1930, however, the figures for apparent consumption have less nearly reflected actual consumption because of the lack of precise data on consumers' stocks. It is thought that these stocks changed very little in 1931 and 1932, increased in 1933, and decreased in 1934. Thus the apparent consumption figures, while fairly accurate for 1931 and 1932, probably are too high for 1933 and too low for 1934.

Apparent consumption of virgin tin in the United States, 1925–34, in long tons

	1925–29 average	1930	1931	1932	1933	1934
Supply:						
Domestic production	24	15	4		[1] 3	8
Imports of tin as metal	78,009	80,734	66,064	34,819	63,718	39,986
Imports of tin in concentrates	175	289	30	17	24	[2] 2
Visible stocks, Jan. 1	[3] 2,844	2,820	4,693	6,254	4,496	7,504
Consumers' stocks, Jan. 1	[4] 10,606	10,606	15,500	[5] 15,500	[5] 15,500	[5] 15,500
Total available	91,658	94,464	86,291	56,590	83,741	63,000
Withdrawals:						
Exports of tin as metal	1,740	2,233	[6] 1,661	[6] 1,116	[6] 1,041	[6] 1,216
Exports of tin in concentrates	24	15	4		[1] 3	8
Visible stocks, Dec. 31	[3] 2,820	4,693	6,254	4,496	7,504	2,638
Consumers' stocks, Dec. 31	[3] 10,606	15,500	[5] 15,500	[5] 15,500	[5] 15,500	[5] 15,500
Total withdrawn	15,190	22,441	23,419	21,112	24,048	19,362
Apparent consumption	76,468	72,023	62,872	35,478	59,693	43,638
Consumption accounted for in Bureau of Mines canvass	(7)	65,448	(7)	(7)	(7)	(7)

[1] Revised figures.
[2] Not strictly comparable with previous years. See footnote "2" in table on foreign trade, p. 506.
[3] Stocks for Jan. 1 and Dec. 31 are stocks at the beginning and end of the 5-year period and not averages of stocks on Jan. 1 and Dec. 31 of each year.
[4] Stocks at the end of the period. Stocks for Jan. 1, 1925 are not available.
[5] 1930 figure repeated in absence of more recent data.
[6] Foreign exports only for 1931–34.
[7] No canvass by Bureau of Mines for 1925–26, 1929, and 1931–34.

The consumption of secondary tin cannot be segregated by various uses in as much detail as that of the virgin metal. Much secondary tin is consumed in the form of alloys by companies that are unable to report the exact tin content of the materials they consume. Less than one-third of the total secondary tin is recovered as metallic tin before reuse. The principal use of secondary tin is in the manufacture of alloys, and most of it so used is reclaimed from secondary alloys without first being converted into the pure metallic state. The alloy scrap is sorted to remove undesirable elements, is melted and analyzed, and then receives enough virgin metals to bring the molten mass to the composition desired. The tin-alloy store of the United States can best be represented as a reservoir containing many metals, into which a stream of virgin tin must constantly flow to replace losses and provide for expansion.

Tin plate and terneplate.—The tin-plate and terneplate industry is the largest user of virgin tin in the United States and has accounted for approximately two-fifths of the domestic consumption during the last few years.

Tin plate is made by coating steel sheets with pure tin, and in present practice standard tin plate contains about 1½ percent of tin by weight; 1 pound of tin will make 220 square feet of tin plate. Terneplate is similar to tin plate, except that an alloy of lead and tin is substituted for pure tin in the coating. Taggers tin is extra-thin tin plate. During the last few years the domestic tin-plate manufacturers have been developing a new technique. Its most important features are a more nearly continuous rolling of the sheet bar to black plate, more dependence on cold rolling for reduction of thickness, and more attention to heat treatment in the annealing processes. Direct labor costs have been reduced sharply, but the outlay required for the new equipment has been very great. The tin plate thus produced, however, is said to be superior to other tin plate, particularly with respect to uniformity of gage and ability to stand deep drawing.

The larger part of the tin plate and taggers tin manufactured is used for making tin cans, particularly food containers. Terneplate is used largely for roofing and for gasoline tanks on automobiles, and some is substituted for tin plate in non-food-product containers where the toxic effect of the lead is not deleterious.

Tin plate and terneplate produced in the United States, 1925–34, in long tons [1]

Year	Tin plate	Terneplate	Total	Year	Tin plate	Terneplate	Total
1925–29 (average)	1,666,585	120,622	1,787,207	1932	986,217	46,290	1,032,507
1930	1,660,325	103,118	1,763,443	1933	1,685,826	83.272	1,769,098
1931	1,392,227	66,716	1,458,943	1934	1,502,918	100,311	1,603,229

[1] From Annual Report of American Iron and Steel Institute.

In 1934 tin was used in the manufacture of 1,502,918 long tons of tin plate and 100,311 tons of terneplate in the United States compared with 1,685,826 and 83,272 tons, respectively, in 1933. Exports of tin plate, terneplate, and taggers tin were 184,299 long tons in 1934, an increase of 94 percent from 1933. Imports of tin plate, terneplate, and taggers tin virtually disappeared in 1933. The United States produced almost twice as much tin plate and terneplate as Great Britain but exported less than one-half as much.

Automobile manufacture.—The automobile industry is one of the principal consumers of tin. The chief uses are in solder for radiators, babbitt for engine bearings, and bronzes for bearings and bushings. The trend in the low price-class from the 4-cylinder type of engine to the 6- and 8-cylinder types has increased the requirements of tin for babbitted engine bearings. On the other hand, tin-free bearing metals are displacing the tin alloys in some of the most popular automobile models.

Production, registration, and exports of motor vehicles in the United States, 1925–34

Year	Production [1]			Registration [2] (all classes)	Exports [3] (all classes)
	Passenger cars	Trucks and busses	Total		
1925–29 (average)	3,771,702	565,352	4,337,054	23,338,400	407,170
1930	2,784,745	571,241	3,355,986	26,632,000	237,582
1931	1,973,090	416,648	2,389,738	25,934,000	130,705
1932	1,135,491	235,187	1,370,678	24,115,000	66,404
1933	1,573,512	346,545	1,920,057	23,844,000	108,027
1934	2,177,919	575,192	2,753,111	24,933,000	237,880

[1] Bureau of the Census.
[2] Bureau of Public Roads.
[3] Bureau of Foreign and Domestic Commerce.

In 1934 there was an increase of 43 percent over 1933 in the number of automobiles produced and an even more marked recovery in the industry's export business. The number of units produced, however, was only one-half that for 1929, the peak year. Another favorable feature was the increase in the number of motor vehicles registered, which reversed a downward trend since 1930. The maintenance and repair of these cars are substantial items in the consumption of tin.

Other manufactures and new uses.—Returning industrial activity during 1934 has increased the need for tin because the moving parts of so many machines run on tin-alloy bearings. Airplanes, mechanical refrigerators, and Diesel engines require much tin for their manufacture and maintenance. The repeal of the prohibition amendment has reopened a large market for tin for breweries, distilleries, and alcoholic beverage retailing and refrigerating equipment.

The tin miners have sought to discover and promote new uses for tin and to defend old uses against substitutes through their International Tin Research and Development Council. On May 25, 1934, the council passed a resolution [8] concerning research activities in the United States from which the following is quoted:

> On the recommendation of D. J. Macnaughtan, Director of Research for the International Council, the Battelle Memorial Institute, Columbus, Ohio, has been appointed to conduct research projects on tin in this country. Work is reported to be well under way, following such lines of investigation as will be of the greatest value to American manufacturers who employ tin for various purposes.

During 1934 the council gave publicity to several new applications for tin and also reported on methods of improving existing uses.

[8] Macnaughtan, D. J., Tin Research and Development: Misc. Pubs., International Tin Research and Development Council, no. 1, 1934, p. 10.

SUBSTITUTES

Tin returned to its position during 1933 as the highest priced of the common base metals, a position it continued to hold throughout 1934. This fact, in conjunction with the monopolistic manipulation of its production, turned the attention of many United States consumers toward research for substitutes, as substitution is virtually the only weapon available to consumers with which to combat excessive price. Moreover, substitution would prove invaluable to national defense should war curtail the flow of tin to the United States.

During 1933 a new outlet for tin plate developed when the petroleum companies began to retail their automobile oils in tin cans to protect consumers against fraudulent substitution of lower grades of oil. In 1934, however, copper-coated steel cans were introduced as a substitute for the tin-plate containers. A tin-free substitute for babbitt was introduced in the automobile industry. In 1934 Germany prohibited the use of tin in bearing metals. On the whole, however, tin maintained its markets very well, despite its high price, but the research for substitutes grew more intense.

PRICES AND STOCKS

Prices.[9]—The price of tin during 1934, though very high compared with that of other commodities and particularly with other metals, was much steadier than it had been in years. This stability reflected the manipulation of production and stocks by the International Tin Committee. The break in the price in February 1935, however, revealed the committee's weakness when confronted with major upsets in the London market. Moreover, the ability of the London tin market to withstand shocks is said to be declining, because tin price stabilization is causing speculators to transfer their activities to other markets. During 1934 much of the dealing in tin was as much affected by the fluctuations in monetary exchange as in tin price.

Monthly price of Straits tin for prompt delivery in New York, 1932–34, in cents per pound [1]

	1932			1933			1934		
	High	Low	Average	High	Low	Average	High	Low	Average
January	22.37½	20.75	21.84	23.45	21.80	22.70	53.20	50.60	51.88
February	22.30	21.50	22.03	23.80	23.20	23.50	52.60	50.00	51.62
March	22.35	20.80	21.86	25.50	23.50	24.34	55.20	52.30	53.74
April	20.25	18.35	19.24	30.25	24.70	27.15	56.65	54.87½	55.60
May	22.12½	20.00	20.95	40.75	32.37½	35.90	54.65	52.65	53.52
June	20.75	18.65	19.64	46.50	40.62½	44.21	52.50	50.25	51.22
July	21.37½	20.40	20.93	48.00	44.62½	46.38	52.37½	51.25	51.92
August	24.37½	21.50	22.96	46.12½	43.37½	44.74	52.90	51.40	51.95
September	25.62½	23.87½	24.76	48.25	44.75	46.65	51.95	51.15	51.49
October	24.50	23.25	23.92	49.00	46.00	47.92	51.30	50.55	50.93
November	24.15	22.00	23.32	55.80	49.00	53.07	51.37½	51.10	51.22
December	22.85	22.45	22.69	53.50	52.35	52.87	51.05	50.70	50.87
Year	25.62½	18.35	22.01	55.80	21.80	39.12	56.65	50.00	52.16

[1] Metal Statistics, 1935, pp. 333 and 335.

[9] Prices used in this discussion refer to Straits tin at New York, as quoted in the American Metal Market and published in Metal Statistics, 1935, pp. 333–335.

It was not until April 1933 that the price of tin started its spectacular climb from the depression level that had prevailed for so many months, and by November of that year it had reached the level held throughout 1934. The price record of tin in 1934 includes a high monthly average of 55.60 cents a pound for April, a low monthly average of 50.87 cents for December, and an average of 52.16 cents for the year compared with the 1933 record of a high average monthly price of 53.07 cents for November, a low monthly average of 22.70 cents for January, and an average of 39.12 cents for the year. The average price per pound for 1934 was thus 13.04 cents (33 percent) greater than that for 1933. The average price for December 1934, however, was 2 cents (4 percent) below that for December 1933.

Prices of tin plate and sheet bars at Pittsburgh and pig tin at New York on dates of principal price changes of tin plate, 1929–34 [1]

Date	Tin plate (per base box)	Sheet bars (per long ton)	Pig tin (per pound)	Date	Tin plate (per base box)	Sheet bars (per long ton)	Pig tin (per pound)
			Cents				*Cents*
1929: Dec. 31	$5.25	$34.00	39.75	1932: Nov. 17	$4.25	$26.00	23.35
1930: Oct. 1	5.00	31.00	28.00	1933: Aug. 29	4.65	26.00	46.00
1931: Oct. 1	4.75	29.00	22.12½	Dec. 1	5.25	26.00	53.50

[1] Metal Statistics, 1935, p. 153.

Stocks.—The monthly average of the world "visible supply" of tin was 17,448 long tons in 1934 compared with 36,239 tons in 1933 and 48,892 tons in 1932; by December 1934 the monthly average had been reduced to 13,698 tons. Thus visible stocks had returned to the 1927 level, when they averaged 14,925 tons for the year. Between 1927 and 1934, however, stocks had been very large and depressing to the market; an all-time high was reached when the stocks averaged 51,707 tons for July 1931.

Visible stocks of tin in the world and in the United States at end of each month, 1925–34, in long tons [1]

Month	1925–29 (average)		1930		1931		1932		1933		1934	
	World	U. S.	World	U. S.	World	U. S.	World	U. S.	World	U. S.	World	U. S.
January	18,912	2,986	29,032	3,081	43,619	4,904	50,043	5,342	44,223	3,461	22,476	8,209
February	19,620	3,027	33,581	3,626	49,339	5,862	51,300	4,578	43,160	2,741	21,694	7,014
March	18,312	2,803	32,972	3,566	48,607	7,917	50,780	3,841	43,528	2,281	20,423	6,459
April	17,765	2,189	36,595	5,687	48,462	6,212	50,716	3,546	42,541	2,040	17,704	5,649
May	19,085	2,384	39,771	6,767	51,231	5,698	50,562	3,981	41,883	3,036	17,371	5,089
June	18,250	2,392	42,611	7,728	51,626	5,633	48,945	3,759	39,964	3,474	17,251	5,094
July	18,164	2,675	41,950	6,786	51,707	5,838	49,125	4.559	38,043	4,549	16,313	6,461
August	18,339	2,450	43,805	7,533	50,987	6,213	47,177	4,459	33,534	5,788	15,494	4,968
September	18,317	2,425	40,150	6,323	50,722	5,868	47,739	4,191	30,162	6,003	15,386	4,243
October	18,356	2,899	39,676	4,823	50,602	6,773	47,048	4,291	27,940	6,664	16,475	4,998
November	19,058	2,373	40,811	5,372	50,583	7,458	47,471	3,441	26,075	6,769	15,094	4,048
December	20,557	2,277	42,498	4,693	51,313	6,254	45,796	4,496	23,812	7,504	13,698	2,638
Average	18,744	2,573	38,621	5,499	49,900	6,219	48,892	4,207	36,239	4,526	17,448	5,406

[1] Metal Statistics, 1935, pp. 325 and 327.

Visible stocks of tin held in the United States had averaged approximately 2,500 long tons for many years, seldom dropping below 1,500 tons and seldom exceeding 7,500 tons, but during the last 5 years the average has been somewhat higher. In 1934 stocks at the close of the month recorded a high point of 8,209 tons in January and a low of 2,638 tons in December; the average for the year was 5,406 tons. This supply, however, would have satisfied the requirements of domestic industry for less than 7 weeks had all other sources been cut off.

The so-called "invisible" stocks of tin are exceedingly difficult to estimate, as they consist largely of stocks held by manufacturing companies, metal merchants, and speculators. At times, smelters hold considerable quantities of tin and tin-bearing materials that do not appear in the world's visible stocks. During 1934 the 8,282 tons being accumulated in the Buffer Pool was concealed as invisible stocks. The decline in visible stocks and the Buffer Pool accumulations increased the proportion of stocks of which there was no public statistical record, notwithstanding the protestations of the International Tin Committee that it sought to increase the usefulness of published tin statistics.

The questionnaires that have formed the basis of the Bureau of Mines studies of domestic tin consumption since 1928 disclose that manufacturing requirements rather than current prices of the metal determine the stocks carried by consumers of virgin tin. During the past year there have been reports that consumer stocks have decreased in the United States.

WORLD PRODUTION AND RESOURCES

The world production of tin in 1934 was 117,000 long tons compared with 90,000 tons in 1933, 94,000 tons in 1932, and 193,000 tons in the all-time peak year 1929. The Bureau of Mines has made available a detailed record [10] of tin production since the beginning of the nineteenth century which shows that annual output, although expanding at a geometrical rate, is increasing more slowly than that of any other important common metal except silver. Thus, if the future may be judged by the past the production of tin will resume its slow expansion as soon as the present dislocation of industry and trade is overcome.

[10] Umhau, J. B., Summarized Data of Tin Production: Econ. Paper 13, Bureau of Mines, 1932, 34 pp.

World production of tin (content of ore), 1925–34, by countries, in long tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1925–29 average	1930	1931	1932	1933	1934
Australia	2,830	1,451	1,750	2,138	2,810	3,000
Belgian Congo	967	652	(1)	689	2,116	4,500
Bolivia [2]	37,169	38,161	31,137	20,589	14,721	20,634
China [2]	7,085	6,483	3,478	2,009	9,459	[3] 8,000
India (British)	2,228	2,990	2,979	3,168	3,472	[3] 3,500
Indo-China	691	992	881	1,010	1,038	1,048
Japan	(1)	1,496	1,577	1,825	[3] 1,800	[3] 1,800
Malay States:						
Federated [2]	54,606	62,065	51,250	27,091	22,826	36,385
Unfederated	2,206	1,910	1,436	1,341	923	[3] 1,000
Mexico	(1)	(1)	761	740	(1)	(1)
Netherland India	33,266	34,586	27,375	16,789	12,609	17,339
Nigeria	8,319	8,570	7,056	4,320	3,755	4,864
Portugal	625	(1)	(1)	550	(1)	553
Siam	8,204	11,526	12,495	9,276	10,324	10,157
Union of South Africa	1,174	930	(1)	540	539	570
United Kingdom (England)	2,658	2,488	598	1,337	1,542	1,900
Other countries [4]	1,000	1,900	1,900	1,000	1,900	1,500
	163,000	176,000	145,000	94,000	90,000	117,000

[1] Less than 500 tons; included under "Other countries."
[2] Exports.
[3] Estimated.
[4] Includes countries producing less than 500 tons.

The international production-control program has been a leading factor in determining tin output and what countries produced it since March 1, 1931. The following table compares 1934 outputs with those for 1930, the last year of unrestricted production.

Comparison of tin productions in 1934 with those in 1930 in countries signatory and nonsignatory to the international production-control program

Country	1930	1934	Ratio of outputs 1934 to 1930
Original signatories:	*Long tons*	*Long tons*	*Percent*
British Malaya [1]	63,980	37,434	59
Bolivia	38,161	20,634	54
Netherland India	34,586	17,339	50
Nigeria	8,570	4,864	57
Total	145,297	80,271	55
Subsequent signatories and adherents:			
Siam	11,526	10,157	88
Belgian Congo	652	4,500	690
Indo-China	992	1,048	106
United Kingdom	2,488	1,900	76
Portugal	460	553	120
Total	16,118	18,158	113
Nonsignatories and nonadherents:			
Australia	1,451	3,000	207
China	6,483	8,000	123
India	2,990	3,500	117
Japan	1,496	1,800	120
Union of South Africa	930	570	61
Others	1,400	1,500	107
Total	14,750	18,370	125
Grand total	176,000	117,000	66

[1] Includes Federated Malay States, Unfederated Malay States, and Straits Settlements.

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Late in 1933 the whole problem of production control was reconsidered, and a new agreement was reached for the 3-year period 1934–36. The basic 1929 outputs were revised slightly, and quotas were set at 40 percent effective January 1, 1934. An extra quota of 4 percent was provided for 1934, which was to be applied in such a way that past quota excesses would be absorbed. Siam's quota was reset at 9,800 tons of tin, computed on the basis of its concentrates containing 72 percent tin. As its concentrates are richer than 72 percent this will limit its annual output to approximately 10,000 long tons of metallic tin. The quota for the original four signatory countries was increased to 50 percent on April 1, 1934 but was returned to 40 percent on October 1, 1934; the 40-percent quota was carried forward into 1935 but was raised to 45 percent for the second quarter of 1935. During 1934 the Belgian Congo, Indo-China, the United Kingdom, and Portugal were induced to join the control scheme but on terms so liberal that their outputs would be affected very little if any. The following table summarizes the quota data of the production-control plan since its inception.

Tin-production quotas (annual) for countries signatory to the tin-production curtailment plan, in long tons

Country	Production (1929)		Quota					New quota basis effective Jan. 1, 1934	Quota		
	Reported by Bureau of Mines	Agreed upon as quota basis	1931		1932				1934 [1]		
			Mar. 1	June 1	Jan. 1	June 1	July 1		Jan. 1	Apr. 1	Oct. 1 [2]
British Malaya	69,371	69,366	53,928	45,375	38,960	30,406	23,115	71,940	28,776	35,970	28,776
Bolivia	46,343		34,260	28,826	24,751	19,317	14,687	46,490	18,596	23,245	18,596
Netherland India	35,236	92,480	29,916	25,171	21,612	16,867	12,823	36,330	14,532	18,165	14,532
Nigeria	10,734		7,992	6,724	5,773	4,506	3,431	10,890	4,356	5,445	4,356
Siam	10,517		(3)	[4] 10,000	10,000	10,000	10,000	9,800	9,800	9,800	9,800
Belgian Congo	971		(3)	(3)	(3)	(3)	(3)		4,500	4,500	[5] 4,500
Indo-China	829		(3)	(3)	(3)	(3)	(3)		1,700	1,700	[6] 1,700
United Kingdom	3,271	24,672	(3)	(3)	(3)	(3)	(3)	14,872	1,700	1,700	[7] 1,700
Portugal	433		(3)	(3)	(3)	(3)	(3)		650	650	[7] 650
Other countries	15,300		(3)	(3)	(3)	(3)	(3)		(3)	(3)	(3)
Total production	193,000	186,518						190,322			
Reduction [8]			36,000	20,000	15,000	20,000	17,040		[9] 8,650	[9] 16,565	16,565
Cumulative reduction [8]			36,000	56,000	71,000	91,000	108,040		99,390	82,825	99,390

[1] An additional 4-percent quota was distributed among the first 4 countries during 1934.
[2] The quota of the first five countries was continued into 1935.
[3] No restriction of output.
[4] Not effective until Sept. 1, 1931.
[5] On Jan. 1, 1935 the quota rises to 6,000 tons and on Jan. 1, 1936 to 7,000 tons.
[6] On Jan. 1, 1935 the quota rises to 2,500 tons and on Jan. 1, 1936 to 3,000 tons.
[7] Quota to continue through 1936.
[8] Applicable only to the first 4 countries.
[9] Increase, not reduction.

British Malaya.—The southern part of the Malay Peninsula, known as British Malaya, comprises three major political divisions—the Federated Malay States, the Straits Settlements, and the Unfederated Malay States.

The Federated Malay States, the world's leading source of tin ore, produced concentrates containing 36,385 long tons of metallic tin in 1934 compared with 22,826 tons in 1933 and 27,091 tons in 1932. The legally enforced curtailment program was the principal factor in the reduction of output during 1931–33, inclusive; of the 118 dredges in use, 62 were idle temporarily at the end of 1934. Employment in the mining industry in the last month of year has been as follows: 1934, 53,037; 1933, 41,740; and 1929, 104,468. Some labor shortage was reported because of the repatriation of Chinese during preceding years and the increasing labor requirements of the rubber plantations. The special export duty on tin ore was raised 50 percent, effective November 1, 1934. Another added cost resulted from a 10-percent increase in the British Malaya to United Kingdom freight rate on pig tin.

The tin miners appeared to be increasingly restive under the restriction of output. During the spring they unsuccessfully opposed the Buffer Pool scheme with a proposal that the mines be permitted to carry a 2-month supply of concentrates available to the International Tin Committee for price stabilization. There also seemed to be a growing demand that British Malaya be allotted a larger proportion of the world production if it were to be induced to support the production-curtailment program after 1936.

The Straits Settlements continued to lead the world in production of smelted tin, but the diversion of Netherland India concentrates from the Singapore smelter to that at Arnhem, Netherlands, decreased the proportion of the world output treated in the Straits Settlements.

The Unfederated Malay States together produced concentrates estimated to contain 1,000 long tons of metallic tin in 1934 compared with 923 tons in 1933 and 1,341 tons in 1932.

Bolivia.—Bolivia, the second largest producer of tin and the largest producer of lode tin, exported concentrates and ore containing 20,634 long tons of tin in 1934 compared with 14,721 tons in 1933 and 20,589 tons in 1932. The Patiño Mines & Enterprises Consolidated, Inc., the world's greatest tin-mining company, produced almost half of Bolivia's tin in 1934.

Military operations against Paraguay in the Gran Chaco area, though not directly interfering with the tin industry, have increased the difficulties of the tin producers because of the added taxation resulting and the enlistment of many of the best workmen in the army. A new method of taxation was developed during 1934, when the Government sold the nation's added quotas instead of prorating them among the mines on a basis of their curtailments.

Netherland India.—Netherland India produced concentrates containing 17,339 long tons of tin in 1934 compared with 12,609 tons in 1933 and 16,789 tons in 1932. As in the past, virtually all the production came from mines operated by the Government and the Billiton Joint Mining Co. In 1933 the Billiton Mining Co. and the Singkep Tin Co. were amalgamated as the Billiton Joint Mining Co. During 1934 negotiations were begun for the absorption of this new Billiton company by the Government's Banka organization, which would bring virtually all tin mining and smelting in Netherland India and the Netherlands under one Government-dominated corporation. Such a consolidation would form a so-called "tin front" which would have enormous bargaining power in any conference for prolonging production-control after 1936. Moreover, it would permit the most efficient exploitation of the colony's tin resources by allowing concentration of efforts on the rich Banka Island deposits during periods of curtailed output. Already greater smelting and marketing efficiency is being developed by marking some of the Arnhem (Billiton Co.) smelter output, "Banka" brand.

Siam.—Siam produced concentrates containing 10,157 long tons of tin in 1934 compared with 10,324 tons in 1933 and 9,276 tons in 1932. Siam's acceptance of an annual quota of 10,000 tons ended the steady climb in production that had continued through 1931.

China.—Exports from China in 1934 were estimated at 8,000 long tons of tin compared with 9,459 tons in 1933 and 2,009 tons in 1932. Production in recent years has come principally from the Kotchiu district in southern Yunnan Province, but developments were reported that promise as much as 20,000 long tons of tin annually from the Fuchuan, Chungshan, and Hohsien districts in Kuangsi Province. The new Kotchiu smelter is said to be producing pig tin that exceeds standard tin in quality.

Nigeria.—Nigeria produced concentrates containing 4,864 long tons of tin in 1934 compared with 3,755 tons in 1933 and 4,320 tons in 1932; all the concentrates were exported for smelting. The Anglo-Oriental Mining Corporation, Ltd., working through its subsidiary, the London Tin Corporation, Ltd., and through substantial stock holdings in numerous producing companies, has brought half of the Nigerian tin production under its control.

Belgian Congo.—The Belgian Congo continued its amazing development program by producing 4,500 long tons of tin in 1934 compared with 2,116 tons in 1933 and 689 tons in 1932. Although the Belgians finally were prevailed upon to join the production-control plan the terms to which they agreed were not very restrictive, as they permit an output of 6,000 long tons of tin in 1935 and 7,000 tons in 1936. During 1934 some of the concentrates were smelted and refined near the mines, and it appears possible that some day the Belgian Congo will export most of its tin output as refined metal.

India.—India continued to increase its tin output, notwithstanding vigorous efforts to induce it to accept production restriction; in 1934 its output was estimated at 3,500 long tons compared with 3,472 tons in 1933 and 3,168 tons in 1932. Production control in Burma, where all the tin is produced, would be very complicated because most of the tin mines yield tungsten as a byproduct, and any curtailment of tin output would affect the tungsten business adversely.

Australia.—Australia likewise found production control unacceptable and produced 3,000 long tons of tin in 1934, compared with 2,810 tons in 1933 and 2,138 tons in 1932.

United Kingdom.—The production of tin (content of domestic ores) in the United Kingdom was 1,900 long tons in 1934 compared with 1,542 tons in 1933 and 1,337 tons in 1932. Beginning with 1934 the United Kingdom accepted an annual quota of 1,700 long tons until 1937. The importance of the United Kingdom in tin production, however, is based upon the output of its smelters at Liverpool and Redruth. The principal tin smelters of the United Kingdom were brought under one management through the formation of Consolidated Tin Smelters, Ltd., at the close of 1929. This monopoly, however, is about to be broken by the Straits Trading Co., Ltd., which has registered the British Tin Smelting & Refining Co., Ltd. (capital £50,000), to establish an independent plant on a site already acquired in the Liverpool industrial area.

Other countries.—The countries discussed separately account for 111,000 long tons (95 percent of the total production) in 1934. The remaining 6,000 tons were produced largely by Japan, Indo-China, the Union of South Africa, and Portugal, but small outputs were reported for Uganda, Southwest Africa, Spain, Cameroun (French), Swaziland, Tanganyika Territory, Argentina, Morocco (French), Mexico, Southern Rhodesia, and France.

Tin smelters.—In recent years the bulk of the tin has been smelted in a very few places; the principal plants were at Singapore and Penang in the Straits Settlements, Liverpool and Redruth in the United Kingdom, and Batavia, Banka, and Billiton in Netherland India. The rising importance of the Arnhem smelter in the Netherlands and the Hoboken plant in Belgium is tending to decentralize the industry, and this decentralization would be carried much farther should legislation growing out of the recent tin investigation by the House of Representatives result in the reestablishment of a large tin smelting and refining industry in the United States.

CHROMITE [1]

By Robert H. Ridgway

SUMMARY OUTLINE

The continued recovery of the international ferrous-metallurgical industries during 1934 affected favorably the position of alloy steels, the principal consuming outlet for chromium ores. Although the production of chromite dropped more than 50 percent from 1929 to the depression low of 1932 the output and sale of chromium ores have increased considerably during the subsequent 2 years. World output increased 94,000 metric tons in 1933 over 1932, and it is believed that a substantial increase was made in 1934, although complete figures are not available. Production in Southern Rhodesia (normally the world's largest producer) in 1934 more than doubled the 1933 output but was only 60 percent of that of Turkey, whose production during the last few years has been an outstanding feature of the industry from an international standpoint. Preliminary figures indicate that the production of chromite in Turkey in 1934 was the largest ever recorded.

The mining of chromite in the United States is unimportant in the light of world production or domestic consumption. The domestic output in 1934 was 341 long tons compared with 966 tons in 1933. The United States, however, ranks first in the consumption of chromite and like most of the other large consuming nations depends on foreign sources. The supply available for consumption was 64 percent above that in 1933. Cuba was the largest source of American imports for consumption in 1934. The following table compares salient statistics of the chromite industry in the United States during the last 5 years with the yearly average from 1925 to 1929.

[1] Figures on imports in the United States compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Salient statistics of the chromite industry in the United States, 1925–34

	1925–29 average	1930	1931	1932	1933	1934
Production----long tons--	262	310	762	200	966	341
Consumption:						
Imports----do----	224, 357	326, 617	212, 528	89, 143	116, 511	[1] 192, 297
Domestic shipments----do----	276	80	268	155	843	369
Apparent available supply----do----	224, 633	326, 697	212, 796	89, 298	117, 354	192, 666
Prices per ton at New York, approximate average of all grades----	$22. 46	$21. 50	$18. 50	$18. 00	$17. 00	$19. 00
Origin of imports:						
Southern Rhodesia---percent of total--	52	45	32	17	10	25
New Caledonia----do----	6	10	19	13	13	10
Turkey----do----	----------	1	1	20	24	15
Greece (largely transshipments from Yugoslavia)----percent of total--	9	14	14	18	10	12
U.S.S.R. (Russia)----do----	----------	4	8	5	11	10
Cuba----do----	15	13	7	----------	20	26
Others----do----	18	13	19	27	12	2
World production----long tons--	428, 000	551, 000	407, 000	291, 000	384, 000	(2)

[1] "Imports for consumption"; "general" imports not available.
[2] Data not available.

Figure 33 shows the trend of domestic consumption and prices during the past 10 years.

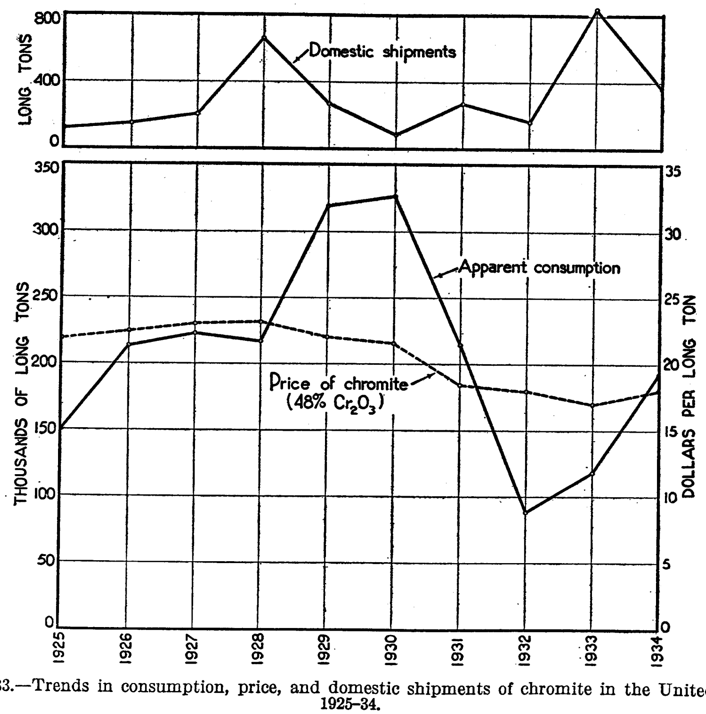

FIGURE 33.—Trends in consumption, price, and domestic shipments of chromite in the United States, 1925–34.

No code of fair competition was signed or submitted for the chromite-mining industry in 1934. The industry is very small and so far as is known had no organization for the formulation of a code.

Planning Committee for Mineral Policy.—The immediate problem of controlling surpluses in the mineral industries and the long-time problem of conservation are discussed in a report submitted to the National Resources Board by the Planning Committee for Mineral Policy. The report was released early in 1935.

Developments in alloy steels and in chromium plating during the last decade have enhanced the importance of chromium as an industrial and strategic element. The only ore of chromium is chromite, which belongs to the group of minerals of which the domestic supply is deficient. Concerning this group the committee recommends "that public encouragement should be given to exploration for new deposits, development of substitutes, and technologic research for making low-grade supplies commercially available." With regard to the international aspects of the deficiency minerals the committee recommends:

1. Consideration of tariffs in the light of the extent, grade, location, and future life of domestic resources.
2. Protection of American interests against any attempts to maintain excessive prices on our needed imports.
3. Restriction or regulation of export of scrap.
4. Establishment of war reserves of imported minerals essential for national defense.
5. Maintenance of trading lines carrying these minerals.

In normal times virtually all of the chromium ore for domestic needs is obtained from imports. In an emergency it is estimated that the United States could produce 25 to 30 percent of its requirements. For mineral raw materials of which the domestic supply is insufficient the committee recommends the establishment of Government stock piles to be held inviolate until actually required for emergency needs. The estimated war needs of chromite for 2 years are given as 300,000 short tons of 50 percent ore. The stock piles may be built up by one or a combination of several methods:

1. By direct purchase in domestic or world markets.
2. By accepting materials in lieu of tariff duty payments.
3. By accepting materials in partial payment of war debts.
4. By using emergency funds to stimulate domestic mining.

DOMESTIC PRODUCTION

In the United States 341 long tons of chromite were mined and 369 tons shipped in 1934 compared with 966 tons mined and 843 tons shipped in 1933. The bulk of the output and all the shipments in 1934 were from California, shipments being reported from San Luis Obispo, Santa Barbara, and Tuolumne Counties.

Exploration was continued during 1934 by the Montana Chrome, Inc., at its properties on the Hellroaring Plateau, 15 miles southwest of Red Lodge, Mont. Only a small production was recorded from this property in 1934.

The following table shows the production and shipments of chromite in the United States from 1930 to 1934.

Crude chromite mined and shipped from mines in the United States (all from California), 1930–34

Year	Ore containing 45 percent or more chromic oxide			Ore containing 35 to 45 percent chromic oxide			Total value
	Mined (long tons)	Shipped (long tons)	Value	Mined (long tons)	Shipped (long tons)	Value	
1930	235	80	$1,905	75			$1,905
1931	612	268	3,509	150			3,509
1932	200	155	2,160				2,160
1933	879	743	(1)	87	100	(1)	11,585
1934	331	320	(1)	[2] 10	49	(1)	4,653

[1] Figures included in total value only. Bureau of Mines not at liberty to publish separately.
[2] Produced in Montana.

IMPORTS

Imports of chromite into the United States were 192,297 long tons in 1934 compared with 116,511 tons in 1933, an increase of 65 percent. The chromite imported into the United States in 1934 had a chromic oxide content of 43 percent. Of the larger quantities of imports in 1934 that from French Oceania (New Caledonia) had the highest content of chromic oxide (50 percent), while that from Cuba had the lowest (32 percent).

Cuba was the principal source of American imports of chromite in 1934, furnishing 26 percent of the total; Rhodesia, which supplies much higher grade ores, was second with 25 percent. Turkey supplied 15 percent, Greece 12 percent, New Caledonia 10 percent, and U. S. S. R. (Russia) 10 percent. The following table shows imports of crude chromite into the United States by countries, from 1930 to 1934.

Crude chromite imported into the United States, 1930–34, by countries [1]

Country	1930 (long tons)	1931 (long tons)	1932 (long tons)	1933 (long tons)	1934 [1]		
					Long tons		Value
					Gross weight	Chromic oxide content	
Africa:							
British: Union of South	24,376	5,379		986	1,473	642	$11,122
French: Algeria and Tunisia			2,206				
Portuguese:							
Mozambique (from Southern Rhodesia)	145,709	68,291	15,496	12,200	[2] 47,375	[2] 21,232	[2] 696,372
Other	2,000	2,000					
Belgium	1,595	482					
Brazil	10						
Canada				49	30	15	495
Cuba	40,982	14,957		23,772	49,370	15,962	260,319
Germany							
Greece	45,822	28,893	16,395	11,499	23,301	10,902	283,989
Guatemala	89	91		2,061	792	384	14,256
India (British)	14,542	8,664	7,857	4,152	400	198	4,554
Netherlands					259	110	5,375
Oceania (French)	31,022	39,579	11,550	15,150	19,530	9,820	252,522
Other Asia					1,100	592	10,539
Turkey in Asia	2,591	2,198	17,602	27,854	28,730	14,098	482,337
U. S. S. R. (Russia)	13,878	17,736	4,800	13,261	19,937	9,014	255,907
United Kingdom	4,001	24,258	13,237				
Yugoslavia				5,527			
	326,617	212,528	89,143	116,511	192,297	82,969	2,277,787

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years, due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports", whereas totals for 1934 represent "imports for consumption."
[2] Of the imports shown for Mozambique for 1934 the Bureau of Foreign and Domestic Commerce credits 13,500 tons, containing 6,155 tons chromic oxide and valued at $215,711 to "Other British South Africa."

The following tables show the imports of chromium alloys and compounds into the United States from 1930 to 1934.

Ferrochrome or ferrochromium and chrome or chromium metal imported for consumption in the United States, 1930–34, in long tons

	1930	1931	1932	1933	1934
Ferrochrome or ferrochromium:					
Containing 3 percent or more carbon (chromium content)	------	------	------	------	------
Containing less than 3 percent carbon, gross weight	153	135	159	188	110
Chrome or chromium metal	------	------	20	48	16

Chromium compounds imported for consumption in the United States, 1930–34

Year	Chromic acid		Chromate and bichromate of potash		Chromate and bichromate of soda		Chromium chloride and sulphate	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1930	177,140	$24,788	1,043	$347	301	$84	----------	----------
1931	1,525	427	4,814	769	63	16	100	$74
1932	2,020	534	786	172	246	65	----------	----------
1933	2,040	629	1,892	417	----------	----------	----------	----------
1934	2,149	1,011	22	5	110	32	----------	----------

CONSUMPTION

Owing to lack of data concerning consumers' stocks, it is impossible to estimate accurately the actual consumption of chromite in the United States. However, the apparent available supply increased from 117,354 long tons in 1933 to 192,666 tons in 1934 but was still below the 5-year average from 1925 to 1929.

The improvement in the consumption of chromite during 1933 and 1934 reflects the increased activity in the steel industry, the principal consumer. The automobile industry in the United States, one of the principal users of chromium-alloy steels and chromium plating, increased its output 43 percent over 1933, making 2,753,111 cars in 1934. The building-construction industry uses stainless steel for decorative purposes and large quantities of chromium-plated plumbing fixtures. Activity in this field did not improve much in 1934, particularly in the types of construction consuming chromium.

The following table shows the apparent available supply of chromite in the United States from 1930 to 1934.

Domestic sales, imports,[1] and supply of crude chromite in the United States, 1930–34, in long tons

Year	Sales from domestic mines	Imports (general)	Apparent available supply	Year	Sales from domestic mines	Imports (general)	Apparent available supply
1930	80	326,617	326,697	1933	843	116,511	117,354
1931	268	212,528	212,796	1934	369	[1] 192,297	192,666
1932	155	89,143	89,298				

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years, due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports", whereas totals for 934 represent "imports for consumption."

USES

METALLURGICAL

Alloy steels.—The increasing application of alloy steels in the transportation and automotive industries continued to advance the domestic production of alloy steel, which in 1934 was estimated [2] to be 23 or more percent above that in 1933. The output of steel ingots gained 13 percent.

Chromium in varying quantities, either alone or combined with other alloying elements, enters into the manufacture of a wide variety of alloy steels designed for specific purposes. Perhaps the most widely known are the steels and irons of the chromium-nickel series which are used widely in the automobile, building, dairy, paper, petroleum, transportation, and chemical industries, as well as in kitchen equipment for restaurants, hotels, and hospitals. Steels containing 25 percent chromium with 12 percent nickel and 29 percent chromium with 9 percent nickel have been adapted to uses in the pulp and paper industry. The addition of 2 to 4 percent molybdenum to steels of the 18–8 class has improved their resistance to corrosion from acetic acid, sulphates, and chlorides and has found uses in the sulphite branch of the paper industry. This type has also been adapted to use in the textile industry where strong corrosive media must be handled. The addition of titanium and columbium to stainless steels reduces susceptibility to intergranular corrosion and has improved the welding qualities of the 18–8 alloy. Selenium has been added to stainless steels to improve machining qualities. Steel containing 16 percent of chromium and 1 percent nickel has been developed for aircraft construction. Inconel, containing 80 percent nickel, 14 percent chromium, and 6 percent iron, is one of the newer corrosion-resistant materials developed for use in industry. Among the 1934 developments was the granting to K. M. Simpson of a patent for making stainless steels in the open hearth.

During the last few years interest in the low-alloy steels has increased, particularly in the structural field where higher tensile strengths are desired. Various combinations of chromium with manganese, silicon, vanadium, molybdenum, and copper are being used for this purpose. This type of steel permits high corrosion resistance and lighter weight without sacrifice of strength.

Ferrochromium, an electric-furnace product which usually contains 65 to 72 percent chromium, is the basic alloy used in the manufacture of most chromium-alloy steels. In general, two grades are recognized, high-carbon ferrochrome containing 4 to 7 percent carbon, and low-carbon ferrochrome containing 0.06 to 2.0 percent carbon. The use of high-nitrogen ferrochrome for grain refinement has improved the quality of heat- and corrosion-resistant steels. According to the Bureau of the Census the production of ferrochrome in 1933 was 19,127 long tons; it was made at 7 establishments compared with 26,502 tons made at 8 establishments in 1931.

The alloys of iron and chromium have been described by Krivobok.[3]

The manufacture of most alloy steels, including the stainless steels, has been under the Code of Fair Competition for the Iron

[2] Steel, Consumption of Alloy Steel is More Diversified in 1934: Vol. 96, no. 1, Jan. 7, 1935, pp. 115–116.
[3] Krivobok, V. N., Alloys of Iron and Chromium: Trans. Am. Society Metals, vol. 23, no. 1, March 1935, pp. 1–60.

and Steel Industry, which was approved by the President on August 19, 1933, for an observation period of 90 days. At the request of the industry the Iron and Steel Code was extended from November 19, 1933, to May 31, 1934. On May 30 the industry submitted certain amendments to improve the workability of the code. After consideration the President approved the amended Iron and Steel Code for an indefinite period. The manufacture of ferrochrome, however, came under the Code of Fair Competition for the Alloys Industry, which was approved September 5, 1934. An amendment to the code, approved December 18, 1934, provided for a change in the organization of the Code Authority. The Code of Fair Competition for the Alloy Castings Industry was approved January 30, 1934. Alloy castings are defined for code purposes as follows:

> Include only castings containing nickel and/or chromium in excess of 16 percent and substantially free from copper, zinc, lead, or tin except that this code shall not apply to alloy castings produced and/or sold as a part of the products, including finished and semifinished parts thereof, of an owning or affiliated company but not sold in the open market as rough alloy castings (as distinguished from finished and/or semifinished parts) in competition with similar rough castings produced by other manufacturers.

Three amendments to this code were approved during 1934.

Chromium plating.—Chromium plating may be divided into two classes—decorative and wear-resisting. The former is encountered more commonly, being used extensively in automobile fittings and hardware, plumbing fixtures, and miscellaneous hardware and cutlery. The bluish white color, hardness, and high resistance to ordinary atmospheric corrosion make chromium plate a desirable finish. The decorative chromium plate is extremely thin (approximately 0.00002 to 0.00004 inch) and usually is put on a soft-steel base, upon which successive layers of copper and nickel have been applied.

As a result of a series of tests it has been found that the customary thin chromium coatings (0.00002 inch) increase the resistance to tarnish but not to corrosion. The tests have been described in two papers. [4]

Wear-resisting plate, while not as well known as decorative plate, has many important industrial applications, including use for dies, rolls, and engraving plates. Usually plate of this type is applied to a steel base hard enough to suit the service required. The depth of the plate ranges from 0.0001 inch up to any reasonable amount.[5] A depth of 0.050 inch is not uncommon.

The deposition of chromium from solutions of chromic and chromous salts has been studied by Kasper, who published the following conclusions: [6]

> (*a*) Simple trivalent chromium baths yield poor deposits at low efficiencies. The bright plating range is exceedingly narrow; (*b*) chromous baths give results which are similar to those of the trivalent baths; (*c*) the use of complexes in order to solve the difficulties inherent in the trivalent bath is unsound; (*d*) the chromic acid bath is inherently superior to solutions containing lower valence compounds.

[4] Blum, William, Strausser, Paul, W. C., and Brenner, Abner, Protective Values of Nickel and Chromium Plating on Steel: National Bureau of Standards Research Paper 712, September 1934, pp. 331–335. Strausser, Paul, W. C., Brenner, Abner, and Blum, William, Accelerated Tests of Nickel and Chromium Plating on Steel: National Bureau of Standards Research Paper 724, October 1934, pp. 519–526.

[5] Nemser, D. A., Industrial Chromium Plating: Iron Age, vol. 133, no. 5, Feb. 1, 1934, p. 14.

[6] Kasper, Charles, The Deposition of Chromium from Solutions of Chromic and Chromous Salts: National Bureau of Standards Research Paper 604, October 1933, p. 525.

The chromium-plating industry was governed by the Code of Fair Competition for the Fabricated Metal Products, Manufacturing and Metal-Finishing and Metal-Coating Industry, approved by the President on November 2, 1933. On May 18, 1934, public hearings were held on a supplementary Code of Fair Competition for the Electroplating and Metal-Polishing and Finishing Industry, a division of the fabricated-metal products, manufacturing, and metal-coating industry. The supplementary code was approved August 22, 1934.

REFRACTORIES

The second largest use of chromite in the United States is in the manufacture of refractory materials such as brick and cement. The ore used for this purpose is imported largely from Cuba, Greece, and the Union of South Africa.

Chrome refractories are neutral metallurgically and quite resistant to many types of slag. Chrome brick is used most extensively in parts of the open-hearth steel furnaces. A new chrome refractory has been introduced to meet the demands for a material that could be substituted more widely for silica brick above the slag line in the open-hearth furnace.

According to the Bureau of the Census, the production of chrome and magnesite brick was 10,640,000 brick valued at $3,091,573 in 1934 compared with 9,027,000 brick valued at $2,579,994 in 1933. Formerly magnesite brick were made in much larger numbers than chrome brick, but in recent years they have been produced in about equal amounts. In addition to the chromite consumed in chrome brick considerable is used in refractory cements.

According to the trade journals the price of chrome brick during 1934 was $45 per net ton.

A Code of Fair Competition for the Refractories Industry was approved by the President on December 8, 1933. An amendment to the code relating to a change in definition was approved on September 27, 1934.

CHEMICALS

In addition to that used in the manufacture of chromic acid for electroplating considerable chromite is consumed in the manufacture of chemicals used principally in the dyeing, tanning, and pigment industries.

According to the Bureau of the Census the production of sodium bichromate and chromate was 27,234 short tons valued at $3,280,994 in 1933, compared with 24,745 tons valued at $3,162,482 in 1931. Figures on the production of potassium bichromates and chromate are not available. The value of the production of chromium salts and compounds, other than sodium, potassium, and chrome tannage, was $303,581 in 1933 compared with $212,080 in 1931, according to the Bureau of the Census.

The manufacture of chromium chemicals came under the Code of Fair Competition for the Chemical Manufacturing Industry, which was approved by the President on February 10, 1934.

PRICES

The prices of chromite quoted in the domestic trade journals are for imported ore and are given in dollars per long ton c. i. f. North Atlantic ports. According to Steel, chromite containing 48 percent chromic oxide was quoted at $18 until late in December, when the quotations were $18 to $18.50. Ore with a lower chromic oxide content usually brings a lower price.

WORLD PRODUCTION

Complete data are not yet available on world output in 1934 but increases in exports and preliminary production figures indicate that world production of chromite was at a much higher rate. The U. S. S. R. (Russia) and Turkey were the largest producers of chromite in 1934, and together with Southern Rhodesia and Cuba showed large increases in output. Production in Southern Rhodesia, however, was still far below capacity. The following table shows the available statistics on world production from 1930 to 1934, inclusive.

Production of crude chromite, 1930–34, by countries, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
Australia	171	61	99	905	(2)
Brazil [3]	10	------	------	------	------
Canada (shipments)	------	------	71	27	42
Cuba [4]	41,640	15,197	------	24,154	50,162
Cyprus (shipments)	1,569	203	1,000	(2)	(2)
Greece	23,402	5,634	1,555	(2)	(2)
Guatemala [4]	90	92	------	2,094	805
India (British)	51,497	20,233	18,152	15,775	(2)
Indo-China	1,451	2,800	------	------	(2)
Japan	11,348	9,675	12,492	19,897	(2)
New Caledonia	61,894	74,150	60,000	41,000	47,275
Norway	------	------	409	326	(2)
Rumania	------	------	------	29	(2)
Southern Rhodesia	205,631	81,623	15,692	35,046	72,099
Turkey (Asia Minor)	29,525	55,216	55,196	75,379	119,844
Union of South Africa	13,725	23,335	19,371	34,078	[5] 46,044
United States (shipments)	81	272	157	857	375
U. S. S. R. (Russia)	[6] 66,720	[7] 67,000	[7] 68,000	112,728	(2)
Yugoslavia	51,576	58,384	43,925	26,248	33,606
	560,000	414,000	296,000	390,000	(2)

[1] In addition to the countries listed, Portugal reported a production of 30 kg of chromite in 1931; average content, 38 percent Cr_2O_3.
[2] Data not available.
[3] Exports.
[4] Imports into the United States. The figures for 1934 represent "imports for consumption"; those for prior years, "general imports."
[5] Shipments.
[6] Year ended Sept. 30.
[7] Approximate production.

WORLD TRADE

Chromite is an important commodity in world trade. Except for the U. S. S. R. (Russia) the main producing countries consume only small quantities, while the main consuming countries produce only a small fraction of their requirements. World exports in 1934 were about 440,000 metric tons compared with 300,000 tons in 1933, an increase of 47 percent. Although Turkey again was the principal exporting country in 1934, its portion of the total exports was only 27 percent compared with 34 percent in 1933. Southern Rhodesia supplied 15 percent, Cuba 12 percent, Union of South Africa 11 percent, New Caledonia 9 percent, U. S. S. R. (Russia) 8 percent, India 7 percent, Yugoslavia 6 percent, and Greece 5 percent. Of the exporting nations, only the U. S. S. R. (Russia) decreased from 1933 to 1934; exports from Southern Rhodesia and Cuba increased over 100 percent.

Figures on imports of chromite into the principal consuming countries in 1934 are not yet complete, but data available indicate that the three principal importing countries in order of importance are the United States, Germany, and Sweden.

A brief summary of activities in the principal chromite producing and consuming countries follows.

Canada.—Canada produced 42 metric tons of chromite in 1934, compared with 27 tons in 1933. All the output in 1933 and 1934 came from the Thetford-Black Lake area of the eastern townships of Quebec.

During the year exploratory work was done on the chromite deposit of the Chromium Mining & Smelting Corporation near Obonga Lake 25 miles south of Collins in northwestern Ontario. The ore, which averages 17 percent Cr_2O_3, will be concentrated and the concentrates shipped to Niagara Falls for smelting. Shipments are expected to start early in 1935.

The chromite deposits of Newfoundland have been described by Snelgrove.[7]

Cuba.—Imports of chromite from Cuba into the United States in 1934 were 50,162 metric tons compared with 24,154 tons in 1933 and none in 1932. Cuban ores are of low grade and are used primarily for refractories.

France.—Imports of chromite into France in 1934 were 27,168 metric tons, compared with 20,511 metric tons in 1933.

Germany.—Germany has no chromite ores, but its industries consume large quantities of ore which of necessity are supplied by imports. Imports were 76,982 metric tons in 1934, an increase of 61 percent over the 47,704 tons imported in 1933. A large part of the imports in 1933 and 1934 came from the Union of South Africa and Turkey.

Greece.—Exports of chromite in 1934 were 22,141 metric tons, a large increase over the 13,713 tons exported in 1933; nearly 50 percent of the exports in 1934 went to the United States.

Guatemala.—The production of chromite in Guatemala in 1934, as represented by the amount imported into the United States, was 805 metric tons. The Vanadium Corporation of America is producing high-grade chromite ore from a property about 110 miles from Porto Barrios.

India.—Production figures in 1934 are not available, but output still was declining in 1933 when 15,775 metric tons were produced. Increased exports indicate a larger production in 1934. Water-borne exports from India increased to 27,744 tons, more than double the 1933 figure. These figures do not include shipments through Mormugao which amount to several thousand tons per year.

New Caledonia.—New Caledonia is one of the important sources of chromite. Production in 1934 is estimated at 47,275 metric tons. Exports were 37,226 metric tons compared with 24,564 tons in 1933.

[7] Snelgrove, A. K., Chromite Deposits of Newfoundland: Geol. Sec., Dept. of Natural Resources, Bul. 1, 1934, pp. 1–26.

A large part of the shipments in 1934 went to the United States, while the bulk of the remainder went to Germany. The largest producers are the Société la Tiébaghi, the Société Chimique du Chrome, and the Talon-Chagrin mine.

Norway.—Imports of chromite into Norway in 1934 are not available, but in 1933 Norway imported 18,217 metric tons. Exports of ferrochrome from Norway in 1934 were 11,887 tons compared with 8,000 tons in 1933.

Philippine Islands.—Development work by the Benguet Consolidated Mining Co. on the properties of the Florianne Mining Co. in the Province of Camarines Sur 10 kilometers northwest of the town of Lagonoy indicates a deposit of 75,000 tons of chromite ore and the possibility of 25,000 tons in outlying deposits. The former company, which has a contract with the latter to develop and operate the property, plans to bring the mine into actual production. Mining will be largely opencast, and the ore will be transported to tidewater on a 10-mile aerial tram. The company also is doing development work on a group of claims adjacent to the Florianne.

The Benguet Consolidated Mining Co. entered into a contract on July 9, 1934, with the Consolidated Mines, Inc., to operate (on a profit-sharing basis) the properties of the latter company in the municipality of Masinloc, Province of Zambales, Island of Luzon, where large reserves are reported to exist. Under a third contract certain deposits of chromite are being explored in the Southern Islands.

Southern Rhodesia.—During the decade 1922 to 1931, inclusive, Southern Rhodesia ranked first in production by a large margin. Subsequently production declined, and in 1932 only 15,692 metric tons were produced. Output in 1934, however, was 72,099 tons, or more than double that of 35,046 tons in 1933. The 1934 figure was still less than half the annual average of 157,000 tons for the 10-year period 1922 to 1931. Exports from Southern Rhodesia were 65,829 in 1934 compared with 32,197 tons in 1933.

Rhodesian chromite is of good quality, assaying more than 48 percent Cr_2O_3, but costs at seaboard are rather high due to the long rail haul to the coast.

Sweden.—Imports of chromite into Sweden declined from 38,660 metric tons in 1933 to 35,552 tons in 1934.

Turkey.—The production of chromite in Turkey during recent years has increased substantially. The output in 1934 was 119,844 metric tons, an increase of nearly 59 percent over the record production of 75,379 tons in 1933. Turkish chromite is produced for export, and while export figures are not available for 1934 it is believed that they exceeded 120,000 tons.

At present five mining companies in Turkey are actively producing chromite for export:[8] (1) Turk Meadeni Sirketi (Anonim Suketi), Ahen Munih Han, Galata, Istanbul; (2) Fethiye Sirketi Madeniyesi T. A. S., Merkez Rihtim Han, Galata, Istanbul; (3) Bastas Turk Maden Ltd., Sirketi, Taptas Han, Galata, Istanbul; (4) Comptoir d'Anatolie, Tahta Kale Cad, 8–10, P. O. Box 266, Istanbul; and (5) Stanley Patterson, Izmir (Smyrna), Turkey. Except for the

[8] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes, Turkey Chrome Production: Vol. 3, no. 10, Oct. 27, 1934, p. 6.

last two, these producing companies operate under contracts with foreign importers. The first is financed by German capital and supplies only German concerns, the second company is financed by French capitalists and exports most of its product to France, while the third is controlled by Swedish and German capital and supplies only Swedish and German importers.

The bulk of the Turkish output of chromite is high-grade ore running from 47 to well over 50 percent Cr_2O_3. At some of the mines the ore is shipped without concentration, while at others washing plants improve the quality of the ore.

U. S. S. R. (Russia).—At present the U. S. S. R. (Russia) probably is the largest producer of chromite. Official figures for the output in 1934 are not available, but estimates have placed it as high as 180,000 metric tons. Production in 1933 was 112,728 tons. Aside from the chromite used in the domestic industry the U. S. S. R. (Russia) exports considerable ore. Exports in 1934 were 36,499 metric tons compared with 41,037 tons in 1933. Only high-grade ores are exported. If world demand for lower-grade ores were increased the export from the U. S. S. R. (Russia) would mount as the bulk of the output comes from deposits in the Ural Mountains which contain only about 40 percent Cr_2O_3. The deposits of higher-grade ores are unfavorably situated as regards transport.

Deposits of chromite were reported [9] to have been discovered near Lake Sevan in the Caucasus. The ore is reported to run 40 to 50 percent Cr_2O_3.

Union of South Africa.—Shipments from the Union of South Africa in 1934 were 46,044 metric tons compared with a production of 34,078 tons in 1933. The ore, all of which is produced in the Transvaal, is usually of low grade, assaying 40 to 45 percent chromic oxide with a high iron content. Its principal outlet is for refractories and the manufacture of bichromate. Exports in 1934 were 46,483 tons compared with 26,683 tons in 1933. The chrome-ore industry of the Union still receives the 7-percent subsidy granted to base minerals exported.

The deposits in the Transvaal occur in the lower part of the norite zone of the Bushveld igneous complex, and extensive reserves are believed to be available. The deposits, while of low grade, have advantages in mining and transport to the coast which permit lower costs than for ores from some of the other regions. Higher-grade ore bodies have recently been developed in the Isitilo Range, 30 miles east of Eshowe, Zululand. The chromite occurs as small grains in highly altered serpentine. The ore is of three types and has the following analysis: [10]

Analysis of ore from Isitilo Range, percent

	Friable ore	Hard ore	Black ore
Cr_2O_3	45.0	49	52
SiO_2	14.0	18	3
FeO	10.4		
MgO	23.2		
Al_2O_3	4.4		

[9] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes, Russian Chromite Deposits Discovered: Vol. 4, no. 4, Apr. 27, 1935, p. 6.

[10] Stuart, Alan, Enrichment of Chrome Ores by Concentration: South African Min. and Eng. Jour., vol. 45, pt. 2, no. 2194, Jan. 26, 1935, pp. 521–522.

Concentration tests in a pilot plant of the first two classes of ore, which represent the bulk of the deposit, gave a chromite concentrate which averaged 56 to 58 percent Cr_2O_3, 3.0 to 4.2 percent silica, 15.55 iron protoxide, 15.46 percent magnesia, and 7.78 percent alumina.

United Kingdom.—The steel industry in the United Kingdom consumes considerable chromite. Data on imports for 1934 are not available, but 29,450 metric tons were imported in 1933, largely from Southern Rhodesia and India.

Yugoslavia.—The production of chromite in Yugoslavia in 1934 was 33,606 metric tons compared with 26,248 tons in 1933. Exports increased from 19,157 tons in 1933 to 27,634 tons in 1934. The United States and Germany were the principal markets for this ore in 1934, each taking 30 percent of the total. France, Austria, and Czechoslovakia also imported significant quantities from Yugoslavia in 1934.

ANTIMONY

By F. M. Shore and H. M. Meyer

SUMMARY OUTLINE

The domestic antimony trade in 1934 was characterized by a marked upturn in prices and an apparent improvement in demand which was supplied in larger measure from domestic sources. The increase in antimony prices was due largely to greater world demand, chiefly from Europe, supplemented in the closing weeks of the year by a strict control of Chinese shipments by the Government-sponsored monopoly. Although new supplies of antimony available for domestic consumption increased materially, some of the leading indicators of antimony consumption suggest an even greater improvement in its actual use in 1934. Large amounts of antimony are employed in storage-battery plates, bearing and babbitt metals, solder, type metal, rubber goods, paints, and fixtures. Its market, therefore, depends upon the rate of general industrial activity and, in particular, upon the activity of those industries whose products account for the larger uses of antimony. Bearing metals and storage batteries, for example, normally account for a large part of the domestic consumption. Antimonial lead is required to meet the demand for antimony to be utilized in battery grids and type metal, major uses of the commodity. As a rule the metal so employed is recycled until it actually is dissipated. The depression changed greatly the usual flow of metal for battery grids. Curtailment of the demand for batteries by the automobile industry forced reclaimed battery grids (antimonial lead) to seek other outlets, and antimonial lead was refurnaced and the product, soft lead, placed on the market, thus adding to the visible supply of soft lead. The revival in the automobile industry during 1934 increased greatly the demand for primary antimony. In 1934 the production of automobiles, the largest users of storage batteries, increased about 43 percent, while the estimated production of babbitt metal increased about 11 percent. The American Bureau of Metal Statistics estimates that the quantity of antimonial pig lead used in the manufacture of lead storage batteries of all kinds in 1934 increased about 17 percent over the 1933 total.

There were notable changes in the sources of antimony supplied for domestic use in 1934. Whereas in 1933 supplies increased from all sources except antimonial lead, in 1934 all grades of imports decreased except antimony ores and antimony-lead ingots, while supplies from domestic sources increased except for production of domestic ore. The net result was a definite increase in the use of antimony from domestic sources.

Data on world production of antimony are incomplete at present, but returns received from countries that accounted for about 80 percent of the output in 1933 indicate a substantial increase in the 1934 production.

The major trends in the domestic trade during the past 5 years are shown in the following table of salient statistics for antimony.

Salient statistics for antimony in the United States, 1930–34

	1930	1931	1932	1933	1934
Average price for year of antimony at New York[1] cents per pound	7.67	6.72	5.62	6.51	8.92
Imports for consumption:					
Antimony in ore short tons	863	4,863	1,328	2,128	2,891
Liquated antimony sulphide do	713	650	435	707	417
Metal do	7,700	3,753	1,508	1,934	1,765
Oxide do	690	746	403	651	269
Exports of foreign antimony do	493	697	123	98	402
Stocks of antimony in bonded warehouse at end of year do	705	702	705	523	570
Production of antimony ore and concentrates do			900	1,133	897
Antimony contained do			419	587	404
Antimony contained in antimonial lead produced from domestic and foreign ores short tons	1,685	964	1,085	927	1,675
Recovery of secondary antimony do	8,082	7,900	6,450	7,400	7,550

[1] According to the American Metal Market.

Prices.—With few interruptions the price of ordinary brands of antimony metal in the New York market trended consistently upward throughout 1934, with an abrupt rise in the last 2 months of the year to the highest level recorded since 1927. The average price for 1934 increased 36.4 percent over 1933, a greater advance than is recorded for any of the leading metals except silver and the highest yearly average since 1929. Heavy demand from Europe, the increasing price of silver, the resumption of monopoly control over the Chinese industry by Hunan Province, and the imposition of additional taxes on exports from China were among the features of the world market that influenced materially the trend of antimony prices during the year.

The monthly average price of antimony metal began the year at a figure slightly under that for December 1933, declined moderately in February, and showed a consistent upward movement through March, April, and May, due largely to increased world demand, chiefly from Europe. Owing to a slackening in world demand at the close of the second quarter of the year the New York price of antimony declined in June but resumed its upward progress in July under a sustained active demand and continued to improve throughout each succeeding month of the year.

Under the stimulus afforded by the action of the Hunan Provincial Government in taking over control of the Chinese industry and market in November and imposing additional taxes on export shipments the price of antimony increased abruptly 31 percent above that in October. The December average price advanced 12 percent more. New York prices for antimony metal throughout the year are outlined by the monthly averages of 7.198 cents per pound in January, 7.172

cents in February, 8.465 cents in May, 7.900 cents in June, and 13.730 cents in December. Thus the monthly average price ended the year 91 percent above that for the initial month, marking the climax of one of the most eventful years in the recent history of the world antimony trade.

During most of the year quotations on Chinese grades for future delivery were at a premium over spot prices. At the close of the year spot prices on American grades were quoted below those for foreign grades.

In the United States the total demand for antimony supplies in 1934 improved over the previous year, and more of the domestic demand was satisfied from domestic production of both primary and secondary supplies.

Needle antimony (powdered) began the year with a weekly average price of 7 to 8 cents per pound, according to quotations published by the Oil, Paint and Drug Reporter. This level prevailed until August 1. During August and September the price range was 7½ to 8 cents and from October to December, inclusive, 7¾ to 8¼ cents per pound. Antimony oxide opened the year at a weekly average price of 8 to 11 cents per pound, declining to 7¾ cents in carload lots and 8 cents for less than car lots in the latter part of April. The prices advanced to 8¼ and 8½ cents, respectively, in the middle of May, where they remained through June and July. For the second week in August the prices for car lots and less than car lots advanced to 9¼ and 9½ cents, respectively. The car-lot price declined to 8¼ cents in early September, advanced to 8½ cents for the week of November 3, 9¼ cents for the succeeding 4 weeks, and 10¼ cents during the concluding weeks of the year.

The London price of foreign antimony metal, according to Metal Industry, opened the year at £27 ($136). The price advanced to £27 10s. ($138) for the week of February 16 and to £29 to £32 ($148 to $163) for the weeks of March 2, 9, 16, and 23. The price continued its advance to the high of £34 ($175) for the weeks of April 13 and 20 but declined abruptly to £26 ($134) in the succeeding week. From then until the week of July 13 the price was unsteady, ranging from £26 10s. to £31 ($134 to $156), but for the week of July 20 it advanced abruptly from £27 10s. ($139) of the preceding week to £35 10s. ($179) and continued steadily upward to the yearly high of £65 to £66 ($321 to $326) in the latter half of December.

New York prices for recent years are shown in the following table:

Prices of antimony (Chinese brands) per 100 pounds at New York City, 1930–34 [1]

Year	High	Low	Average	Year	High	Low	Average
1930	$8.875	$6.750	$7.667	1933	$7.750	$5.400	$6.528
1931	7.625	6.050	6.720	1934	13.750	7.150	8.901
1932	7.000	5.000	5.592				

[1] Compiled from Engineering and Mining Journal.

Stocks.—Stocks of needle or liquated antimony and regulus in bonded warehouses were 728,125 pounds at the end of January 1934, declined to 625,757 at the end of February, and thereafter rose steadily to the high figure of the year—1,724,263 pounds—at the end of July. For the next 4 months stocks of antimony decreased steadily to 1,034,197 pounds at the end of November. The bonded stocks increased slightly to 1,139,477 pounds at the end of December, a gain of approximately 9 percent over stocks on hand at the beginning of the year.

DOMESTIC CONSUMPTION

Definite information regarding the quantity of antimony consumed in the United States annually is not available. Consumption is indicated approximately by the total supplies made available from domestic and foreign sources, subject to possible modifications by changes in industrial stocks and in the use of substitutes. The quantity of antimony available for domestic consumption is estimated to have been substantially larger in 1934 than in 1933. The increase in supply is accounted for chiefly by larger imports of ore and antimony-lead alloys, increased quantities of primary antimony in byproduct antimonial lead, and a modest gain in production of secondary antimony. Decreased production of domestic ore and smaller quantities of antimony imported as metal and in liquated antimony sulphide, oxide, and other compounds offset partly the larger supply from other sources. It is of interest to note the increasing reliance of the domestic market upon secondary supplies, which accounted for about 32 percent of the antimony available for consumption in 1920–24, 40 percent in 1925–29, and 45 percent in 1930–34.

DOMESTIC PRODUCTION

The mine production of antimony ores and concentrates in the United States in 1934 was 897 short tons with an antimony content of 404 tons—decreases from the 1933 totals of 20.8 and 31.2 percent, respectively. The production reported came from the operations of the Yellow Pine Co. in Valley County, Idaho.

The production of antimony oxides and other compounds in 1934, from foreign ores and metal and from byproduct treatment, was 5,137,956 pounds, an increase of 49.6 percent over the revised figure of 3,435,332 pounds for 1933.

The Bureau of Mines is not at liberty to publish figures showing the domestic production of metallic antimony in 1934. The principal producer is the Texas Smelting & Refining Co., which operates a plant at Laredo, Tex.

An interesting result of the higher prices in 1934 was the increased number of inquiries regarding market possibilities received by the Bureau of Mines from owners of deposits containing antimony ores. Although no new operations were reported apparently a number of owners are seriously considering the possibility of profitable operation at the price levels of recent months.

Metallic antimony and antimonial-alloy products (antimonial pig lead) were included within the provisions of the Code of Fair Competition for the Lead Industry, which became effective June 4, 1934.

The antimony content of the byproduct antimonial lead produced in the United States from both foreign and domestic ores in 1934 totaled 1,675 short tons, an increase of 80.7 percent over 1933 and the largest output since 1930. The antimony content of the 16,607 tons of byproduct antimonial lead produced at primary plants in 1934 from both primary and secondary sources included 588 tons of secondary antimony compared with 793 tons of secondary antimony in the 17,805 tons of antimonial lead produced at primary plants in 1933. Of the new antimony contained in the antimonial lead produced in 1934, 1.1 percent was of foreign origin compared with 6.1 percent in 1933.

Alaska reported no marketed production of antimony in 1934. The report of the United States Geological Survey covering the mineral industry of Alaska in 1933 contains the following comment concerning antimony:[1]

> Antimony ores are widely distributed throughout Alaska, and in the past considerable quantities were produced and shipped from the Territory. In 1933, however, so far as reported to the Geological Survey, no antimony ores were sold, and no prospecting is known to have been done on lodes solely valuable for the antimony they contain. However, according to reports received from the owner, the annual assessment work required by law was kept up on tne property near Point Caamano, about 20 miles north of Ketchikan, at which prospecting has been in progress for several years. Many of the lodes of the other minerals, notably gold, contain considerable stibnite, the sulphide of antimony, and in the course of mining them some antimony is necessarily taken out, though most of it is lost in the tailings. At a few mines, as in the Fairbanks district, some of the larger masses of stibnite are laid aside until enough has accumulated to be worth shipping. The present low price of antimony and the remoteness of most of these deposits in interior Alaska do not encourage their development at this time.

Mine production of antimony ores and concentrates in the United States, 1930–34, in short tons [1]

Year	Ore and concentrates	Antimony content	Year	Ore and concentrates	Antimony content
1932	900	419	1934	897	404
1933	1,133	587			

[1] No production reported for 1930–31.

Byproduct antimonial lead produced in the United States from both foreign and domestic ores, 1930–34

Year	Short tons	Antimony content		Year	Short tons	Antimony content	
		Short tons	Value [1]			Short tons	Value [1]
1930	13,711	1,685	$258,500	1933	(2)	927	$121,000
1931	(2)	964	129,600	1934	(2)	1,675	299,000
1932	(2)	1,085	122,000				

[1] Calculated at average yearly price for ordinary brands of antimony as given by American Metal Market.
[2] Figures not available. Total byproduct antimonial lead produced at primary plants from primary and secondary sources in 1931 was 21,842 tons; in 1932, 21,024 tons; in 1933, 17,805 tons; and in 1934, 16,607 tons.

Recovery of secondary antimony.—The recovery of antimony from old alloys, scrap, and dross in 1934 was 7,550 short tons, according to J. P. Dunlop, of the Bureau of Mines. This total, most of which was recovered in the form of alloys, represents an increase of 2 percent over the production of secondary antimony in 1933. Owing to the higher prices for antimony that prevailed in 1934 the increase in the value of the secondary output was much greater than the increase in

[1] Smith, Philip S., Mineral Industry of Alaska in 1933: U. S. Geol. Survey Bull. 864–A, 1934, pp. 79–80.

production, amounting to 39.8 percent. Of the total secondary antimony recovered in 1934, 588 tons, 25.9 percent less than in 1933, were recovered from antimonial lead scrap treated at regular smelters, while 6,962 tons, and increase of 5.4 percent, were recovered as metal and in alloys at secondary smelters.

Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1930–34

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1930	8,082	$1,239,800	1933	7,400	$963,500
1931	7,900	1,061,800	1934	7,550	1,346,900
1932	6,450	725,000			

[1] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

IMPORTS AND EXPORTS [2]

Imports.—Except for ores and antimony-lead ingots, all classes of antimony imported for consumption in 1934 declined in quantity from their respective totals in 1933. Liquated antimony sulphide (needle antimony) declined 41 percent in quantity and 37.4 percent in value, and antimony metal imports dropped 8.7 percent in quantity but increased 15.2 percent in value. The decline in 1934 imports of antimony oxides and other compounds was 57.2 percent in quantity and 40.4 percent in value. Due, perhaps, to the marked increase in prices of antimony products in 1934, more ore was imported for domestic consumption than in 1933; the gain in antimony content of the ore was 35.9 percent in quantity and 48.8 percent in value. On account of the large increase in the cost of metal imports, the total value of all classes of antimony imported for consumption in 1934 increased about 16 percent, although the total tonnage, including antimony content instead of gross weight of ore, was only slightly more than in 1933.

As has been customary in recent years, Mexico was the chief source of supply for imported antimony ores in 1934, furnishing 91.3 percent in gross weight and 85.1 percent in antimony content of ore. Argentina, which shipped no ore to this country in 1933, was next in importance, supplying 308 short tons of ore having an antimony content of 173 tons. China retained her traditional position as the chief source of antimony metal imports, supplying 1,594 short tons, or 90.3 percent of the total imports of metal.

Imports of antimony in type metal, antimonial lead, and antimony-lead ingots increased from 301 tons in 1933 to 586 tons in 1934, or 95 percent. Imports of antimony-lead ingots containing nearly 86 percent antimony were reported for the first time in 1933.

Exports.—Exports of foreign antimony from the United States are never large. However, they increased 310.2 percent in 1934 over 1933 to the largest amount recorded since 1931. The United Kingdom and Canada were the chief destinations of the antimony exported in 1934.

[2] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Antimony imported for consumption in the United States, 1930–34

Year	Antimony ore			Liquated antimony sulphide		Antimony metal		Antimony oxides and other compounds	
	Short tons	Antimony content		Short tons	Value	Short tons	Value	Short tons	Value
		Short tons	Value						
1930	1,461	863	$91,499	713	$45,806	7,700	$883,448	783	$119,314
1931	14,015	4,863	259,952	650	30,481	3,753	357,907	833	111,500
1932	3,679	1,328	74,397	435	14,452	1,508	108,241	471	42,014
1933	5,445	2,128	106,662	707	42,727	1,934	137,541	704	59,559
1934	8,455	2,891	158,672	417	26,761	1,765	158,414	301	35,507

Antimony imported into the United States, 1933–34 [1]

Country	Antimony ore			Antimony metal	
	Gross weight (short tons)	Antimony content		Short tons	Value
		Short tons	Value		
1933					
Belgium				2	$178
Bolivia	585	376	$24,674		
Chile [2]	22	11	1,060		
China				2,447	158,678
Germany				2	172
Mexico	4,838	1,741	80,928	84	10,741
United Kingdom				23	3,736
	5,445	2,128	106,662	2,558	173,505
1934 [1]					
Argentina	308	173	12,726		
Belgium				2	174
Bolivia	235	163	12,349		
Chile [2]	65	39	2,044		
China	17	12	1,130	1,594	135,273
Germany				1	121
Mexico	7,720	2,460	126,318	122	14,256
Italy	110	44	4,105		
United Kingdom				46	8,590
	8,455	2,891	158,672	1,765	158,414

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

[2] Imports credited to Chile originated mainly in Bolivia.

Type metal imported for consumption in the United States, 1930–34 [1]

Year	Type metal and antimonial lead		Assumed antimony content		Year	Type metal and antimonial lead		Assumed antimony content	
	Short tons	Value	Short tons	Percent		Short tons	Value	Short tons	Percent
1930	328	$32,934	53	16.2	1933	[2] 371	$29,958	301	81.1
1932	6	479	1	16.7	1934	[3] 112	6,784	18	16.1

[1] No imports reported for 1931.

[2] Of the 1933 imports, 346 tons, containing 49 tons of lead (297 tons assumed antimony), were high-antimony-bearing antimony-lead ingots.

[3] In addition 661 tons of high-antimony-bearing antimony-lead ingots containing 93 tons of lead (568 tons assumed antimony) were imported in 1934. These quantities are included by the Bureau of Foreign and Domestic Commerce under "babbitt metal, solder, white metal, and other combinations containing lead."

Foreign antimony (matte, regulus, or metal) exported from the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	493	$54,634	1933	98	$9,321
1931	697	74,668	1934	402	42,415
1932	123	11,820			

WORLD SOURCES AND PRODUCTION

Antimony ores are found in many parts of the world, but often they are limited in extent or accessibility and cannot compete successfully in the world market except in times of large world demand or interruptions to normal output, with accompanying high prices. The extent of world reserves is not known accurately, but enough information is available to assure consumers of adequate supplies for a great many years at the rate of use that has prevailed in the past.

The potential productive capacity of the world is much greater than normal requirements, and the actual output can be expanded on relatively short notice to meet abnormal increases in demand. During the war period of 1914–18, for example, the average annual production was about 44,500 metric tons compared with an average for the period of industrial activity of 1925–29 of 28,500 tons and about 20,000 tons for the years 1930–34. This ability of the industry to adjust output to meet unusual demands is indicated by an increase in production over the previous year of 45 percent in 1915, 122 percent in 1916, and 46 percent in 1925.

Antimony is produced with considerable regularity in about a dozen countries, but in most of them the output is small and has little influence upon the world market. In times of high prices, however, the smaller countries enter the market in larger degree and, in addition to their increased contributions to the greater needs, tend to restore world prices to normal levels. Another factor restraining continued high prices for antimony is the entry of substitutes into the field of uses ordinarily served by antimony products. Thus, a measure of assurance is afforded against any sustained period of excessive prices of antimony in the world market.

Because of the various, and not strictly comparable, terms in which production is reported in most foreign countries the Bureau of Mines endeavors to reduce all statistics of production to a common basis—the recoverable metal content of the ore produced. Figures of the antimony content of antimonial lead ores are, as far as possible, excluded from the statistics of world production published by the Bureau.

As antimony is a factor in the metal markets of the leading industrial countries its price in each country is related closely to world demand. The relation between world demand, as indicated by world production, and the price of metallic antimony in New York, is shown for the period 1912–34 in figure 34. The production curve represents the estimated recoverable content of antimony ore exclusive of antimonial lead ore, while the price curve shows the annual average price per pound, duty paid.

The total world production of antimony in 1934 is not yet known, but returns already received from countries which normally produce a large proportion of the total world tonnage indicate a substantial increase in the 1934 output. This increase is to be expected from the relatively high level of prices that prevailed in 1934, which would tend to increase the output from all sources and to bring into the market some of the smaller high-cost operations that cannot compete in a period of low prices. For many years China has been the leading source of antimony supplies, her production averaging about 70 percent of the world total during the 10 years preceding 1934. Although the production from China increased materially in 1934 a greater percentage of increase is indicated from other sources which would slightly lower the ratio of Chinese production to the world total. The output of China in 1934, based on antimony content of antimony products, represents an increase of 12.7 percent over that for 1933. Mexico is easily second among the countries for which data are available at present, with an increase of 37 percent over 1933. The production of Algeria increased 20 percent and that of Spanish Morocco 106 percent. Production in

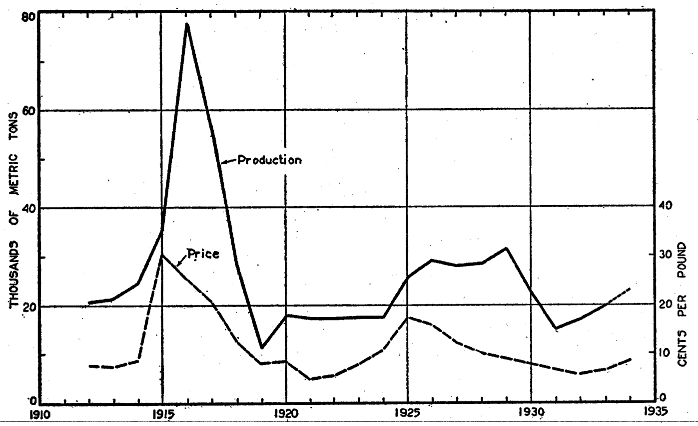

FIGURE 34.—World production of antimony (approximate recoverable metal content of antimony ore produced) and average price per pound in New York, 1912–34. Data on world production in 1934, as shown by the dotted line, are subject to revision.

the United States declined 31 percent in 1934. The production of the five countries named comprised about 82 percent of the world total in 1933.

China.—The developed antimony resources of China are of such magnitude that the country can dominate the world market in the production of antimony. It is of interest therefore to consider briefly the principal developments in the Chinese antimony trade in 1934. Exports of antimony of all grades from China in 1934 were approximately 16 percent greater in tonnage than in 1933. The principal destinations for Chinese antimony exports were, in order, Great Britain, United States, Japan, Germany, and the Netherlands, the same relative rank as in 1933. Shipments to Great Britain increased about 18 percent over 1933, those to the United States declined 13 percent, and the quantity exported to Japan was about the same as in the preceding year. Exports to Germany and the Netherlands in 1934 increased approximately 78 and 57 percent, respectively, over 1933. Although smaller than those for the other countries named above, the exports of antimony from

China to France more than doubled in 1934. Of the total exports of antimony from China in 1934 about 83 percent was regulus, 11 percent crude, and 6 percent "refuse and oxide." [3] Exports by grades for 1933 and 1934, in metric tons, were as follows:

	1933	1934	Change from 1933, percent
Crude	1,631	1,805	+10.7
Refuse and oxide	1,132	930	-17.8
Regulus	11,170	13,450	+20.4

The antimony industry of Hunan Province improved decidedly in 1934. Production is estimated to have increased about 15 percent and exports from Changsha the same amount, while prices more than doubled. The output of antimony in Hunan Province, which is generally regarded as the source of approximately 95 percent of the antimony produced in China, is shipped exclusively through the port of Changsha. Despite the order of the Hunan Bureau of Reconstruction prescribing a maximum monthly production of 500 tons beginning with February the total output in the first quarter was 2,700 tons, or slightly below the record for the fourth quarter of 1933.[4] Prices advanced materially during the first quarter. In terms of American currency, the price of antimony metal at Hankow increased from $92.98 per long ton on January 31 to $108.23 on March 31. The original order limiting production was revised, effective in March, to permit a maximum monthly output of 800 tons, but there appears to have been little observance by the mines of the limit stipulated, and it is estimated that production in the second quarter was 3,000 tons. This period is said to have been one of the most active in the history of the Chinese antimony trade, due to an abnormally large demand from abroad which resulted in the rapid rise of prices to the highest figure since May 1931. The Antimony Trade Association took advantage of the boom to dispose of a substantial part of its stocks. At the end of the second quarter demand slackened, and prices declined, but they continued at levels substantially above those of recent months. The principal demand came from Europe and appears to have been due to unexpectedly heavy buying by Russia from intermediate sources. Production was maintained at the same high level during the third quarter of the year, which was also characterized by continued large shipments abroad, reduction in stocks, and increasingly higher prices.

Stocks of antimony at Changsha (outlet for antimony products from Hunan Province), at Hankow, and at the mines were 5,325 long tons at the end of January, increased to 5,550 tons at the end of March, and ranged from 4,904 to 3,874 tons during the following 6 months, receding to the low of 3,809 tons at the end of October. At the end of the year stocks had reached the high point of 6,378 tons.[5]

[3] Statistical Department of the Inspectorate General of Customs, Monthly Returns of the Foreign Trade of China, December 1934, the Maritime Customs, China. I: Stat. Ser. 8, Shanghai, 1935, pp. 28 and 29.

[4] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes.

[5] Bureau of Foreign and Domestic Commerce, Monthly Reports of the Antimony Situation in the Hankow-Changsha-Shanghai Districts, 1934.

Declared exports from China to the United States (mostly regulus) were 705 long tons in the first quarter, 840 tons in the second quarter, 625 tons in the third quarter, and 150 tons in the last quarter of the year.

In November the Hunan Provincial Government, through the Hunan Antimony Syndicate,[6] which had found little success in its earlier efforts to control the antimony trade of the Province, assumed firm control of the situation. Virtually all unsold stocks at Changsha (estimated at 2,700 long tons) were reported bought up by the syndicate at the high prevailing price of silver, $640 per long ton. An export tax of silver, $6 per long ton, was placed by the Hunan Government on regulus, and a tax of silver, $3 per ton, on lower-grade antimony products leaving the Province. In addition, a tax of 6 percent of the value of shipments from the mines is collected as a sinking fund for the development of the industry. A system of shipping permits for the movement of antimony from the mines to Changsha was instituted in addition to the permits required for export shipments, the collection of the tax and the issuance of shipping permits being placed in the hands of the Bureau of Reconstruction.[7] The year ended with production, sales, and exports of antimony under full control of the Hunan Provincial Government and considerable uncertainty in the trade as to the course of future events.

World production of antimony, 1930–34, in metric tons [1]

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1930	1931	1932	1933	1934
North America:					
Canada	----	6	----	----	----
Mexico	3,042	2,230	[2] 1,388	[2] 1,559	[2] 2,134
United States	----	----	304	426	293
South America:					
Bolivia [3]	927	1,078	1,176	1,517	(4)
Peru	[3] 47	[3] 24	[3] 14	32	(4)
Europe:					
Czechoslovakia	307	513	480	1,090	(4)
France	992	660	512	(4)	(4)
Greece	54	217	262	(4)	(4)
Italy	330	269	302	291	(4)
Yugoslavia	3	286	----	----	(4)
Asia:					
China [5]	17,768	10,104	12,468	13,800	15,548
Chosen	----	----	3	8	(4)
India, British	1	----	----	----	(4)
Japan	----	1	16	32	(4)
Turkey (Asia Minor)	26	34	----	36	(4)
Africa:					
Algeria	----	6	214	419	503
Morocco, Spanish	----	80	121	120	247
Southern Rhodesia	27	----	----	----	----
Oceania:					
Australia:					
New South Wales	42	38	61	42	(4)
Queensland	----	----	----	1	(4)
	23,600	15,600	17,300	20,000	(4)

1 Approximate recoverable metal content of ore produced (80 percent of reported content), exclusive of antimonial lead ores.
2 Includes antimony content of antimonial lead.
3 Exports.
4 Data not available.
5 Figures represent antimony content of regulus, crude antimony, and oxide exported.

6 The term "Hunan Antimony Trade Association" is a literal translation of the Chinese name of the organization which later adopted "Hunan Antimony Syndicate" as its official name in English.
7 Bureau of Foreign and Domestic Commerce, Foreign Tariffs Division.

ARSENIC

By A. V. Petar and C. N. Gerry [1]

SUMMARY OUTLINE

The arsenic industry prospered in 1934; total sales of domestic white arsenic—15,623 short tons—were exceeded only in 1930, and imports were the largest on record, bringing the apparent supply to an all-time high of 29,733 short tons. Sales of both crude and refined arsenic exceeded production, indicating an aggregate reduction in stocks of more than 2,500 short tons. The greatly increased demand for arsenic may be accounted for in part by purchases by the Bureau of Entomology, Department of Agriculture, of nearly 4,000 short tons of crude arsenic for killing grasshoppers. The recent trend toward the use of crude instead of refined arsenic progressed at such an accelerated rate that, for the first time in the history of the industry, sales of crude arsenic exceeded those of refined.

Salient statistics for arsenic in the United States, 1925–29, 1931–34

	1925–29 (average)	1931	1932	1933	1934
WHITE ARSENIC					
Domestic sales: [1]					
Crude short tons	2,364	1,795	1,975	3,029	9,030
Refined do	10,035	11,982	10,508	8,768	6,593
Imports for consumption do	10,769	7,791	6,882	10,583	14,110
Apparent supply [1] do	23,168	21,568	19,365	22,380	29,733
Average value for domestic sales: [1]					
Crude cents per pound	2.69	2.18	2.28	2.42	2.36
Refined do	3.57	3.00	2.67	2.79	2.82
OTHER ARSENICALS					
Imports for consumption:					
Metallic arsenic pounds	208,672	28,661	45,474	100,258	61,918
Sulphide (orpiment and realgar) do	575,506	598,194	502,531	674,002	628,326
Arsenic acid (H_3AsO_4) do	14,692	12,061	1,703	150	100
Calcium arsenate do	1,452	40,950	4,500	11,023	24,000
Lead arsenate do	[2] 2,133			1,000	
Sheep dip do	135,929	154,530	62,509	106,751	237,037
Paris green and london purple do	4,402	2,340	2,364	46,051	8,899
Sodium arsenate do	82,105	9,284	5,763	4,974	8,244
Exports:					
Calcium arsenate do	[3] 2,159,168	2,145,653	2,533,599	2,585,824	3,356,342
Lead arsenate do	[3] 1,328,828	1,788,345	1,189,629	598,699	650,256

[1] Includes sales by domestic producers for export.
[2] 10,467 pounds in 1925 and 200 pounds in 1929; no imports from 1926 to 1928, inclusive.
[3] Average for 1928-29; exports of calcium arsenate and lead arsenate not separately recorded by Bureau of Foreign and Domestic Commerce prior to 1928.

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

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Domestic production and sales.—The production of arsenious oxide (white arsenic) in the United States rose in 1934 to 13,096 short tons—an increase of 23 percent over the output of 10,650 short tons in 1933 and slightly more than the 1925–29 average. Due to the unprecedented demand more than two thirds of the domestic production (8,997 short tons) was in the form of crude arsenic whereas ordinarily crude constitutes no more than one third. The output of refined arsenic in 1934 was only 4,099 short tons, a substantial reduction from the output during the previous year (7,181 tons). As in 1933, there were four producers of arsenic—the Anaconda Copper Mining Co., the U. S. Smelting, Refining & Mining Co., the American Smelting & Refining Co., and the Jardine Mining Co. The products for the market were refined white arsenic, crude white arsenic, refinery crude, treater dust, and flue dust. No production of red or yellow arsenic sulphide or elemental arsenic was reported for 1934.

Sales of domestic refined and crude arsenic totaled 15,623 tons valued at $797,278. Approximately 58 percent (9,030 short tons) was sold as crude white arsenic for $425,680, and the rest (6,593 short tons) was sold as refined white arsenic for $371,598. This upset in market requirements for white arsenic is explained largely by the heavy purchases of crude material for grasshopper control, but a trend toward increased sales of crude arsenic has been apparent for 2 years or more.

Prices.—For the first time since 1927 white arsenic was quoted in trade journals at less than 4 cents per pound. An indication of a break in the price came early in July when Japanese arsenic, in cases, was quoted at 3 to 3½ cents per pound. This quotation was later revised to 3½ to 4½ cents, but in October quotations for the domestic product in kegs were reduced to 3½ cents for carload lots and 4½ cents for less than carload shipments.

The average receipts actually obtained from sales by producers in 1934, as reported to the Bureau of Mines, were 2.82 cents per pound for refined and 2.36 cents for crude arsenic compared with 2.79 and 2.42 cents, respectively, in 1933. These figures, of course, are exclusive of freight which, on shipments to eastern destinations, averages about 0.5 cent per pound.

Prices quoted on the London market during 1934 failed to recover from the decline of 1933, and contrary to the custom of earlier years quotations for Cornish white instead of being higher were the same as, and at times even lower than, those for Mexican arsenic. During the first 4 months of the year both products were quoted at £16 per long ton, or at the then-prevailing rate of exchange, between 3.60 and 3.68 cents per pound. During the same period Continental arsenic was quoted at £15 to £16 per long ton, or about 3.38 to 3.68 cents per pound. A mark-up of 10s. in the price of Cornish white during May and June was canceled later, and subsequently Cornish arsenic dropped to £15. Mexican arsenic held nominally at £16 throughout the year, but the Continental product was shaded to £14 10s. in August and £14 5s. in November. Even in May, when a drop in the dollar helped to boost the equivalent price of Cornish white above 3¾ cents per pound, European prices tended to remain below New York parity.

As in 1933 quotations for arsenic compounds were generally higher than for a number of years. The price of imported red arsenic rose gradually from 14 to 14¾ cents per pound in January to 15¾ to 16½ cents per pound in November, remaining in that range for the rest of the year.

Quotations for calcium arsenate, as recorded by the Oil, Paint, and Drug Reporter, were altered to reflect regional conditions. In November and December, for example, prices in specified market areas were as follows: East of Rockies—6 to $6\frac{1}{2}$ cents per pound to jobbers, $6\frac{1}{4}$ to $7\frac{1}{2}$ cents to dealers, and $6\frac{3}{8}$ to 8 cents to consumers; southern cotton States—6 to $6\frac{1}{2}$ cents per pound to jobbers, $6\frac{1}{4}$ to $6\frac{1}{2}$ cents to dealers, and $6\frac{1}{2}$ to 7 cents to consumers. In all these quotations the lower figure indicates car lots and the higher figure smaller quantities. During the latter half of 1933 the quotation was reported at 7 to 8 cents or slightly higher than corresponding figures in 1934.

Lead arsenate likewise was quoted in greater detail during the spring and early winter. The January quotation was 10 to $11\frac{1}{2}$ cents per pound, but following a rise in March the entire range of prices dropped a cent in April and continued downward to 7 to 9 cents in July, and remained in that range until November. Quotations during the last 2 months of 1934 were: East of Rockies—9 to $9\frac{1}{2}$ cents to jobbers, $9\frac{1}{4}$ to $10\frac{1}{2}$ cents to dealers, and $9\frac{3}{8}$ to 11 cents to consumers; west of Rockies—9 cents to jobbers, 10 cents to dealers, and 11 cents to consumers.

In February 1934, quotations for sodium arsenate rose from the 1933 level of $7\frac{3}{4}$ to $8\frac{3}{4}$ cents per pound to $10\frac{1}{2}$ cents, a price that was in effect for the remainder of the year. For sodium arsenite (liquid), a price range of 40 to 75 cents per gallon was quoted throughout most of the year.

A supplementary Code of Fair Competition for the Agricultural Insecticide and Fungicide Industry, approved May 1, 1934, provided (art. V, sec. 1 (a)):

> During the period of an emergency and after the lowest reasonable costs of products of the industry have been approved in accordance with the provisions of article IV, section 7 (g), it shall be an unfair trade practice for any member of the industry to sell or offer to sell any products of the industry for which the lowest reasonable cost has been determined at such prices or upon such terms or conditions of sale that the buyer will pay less therefor than the lowest reasonable cost of such products.

In July, the Code Authority for the Agricultural Insecticide Industry declared an emergency in lead and calcium arsenate markets because of price cutting.

Uses.—Domestic sales of white arsenic during 1934 were distributed approximately as follows: Insecticides (including grasshopper control) 69 percent; weed killer and fungicides, 9 percent; glass industry, 3 percent; wood preservative, 1 percent; and exports, 18 percent. These percentages are in line with those of recent years although, considering the heavy purchases for grasshopper control, they do indicate a slump in sales of insecticides.

Although arsenic is useful for diverse purposes, the most important and the most sensitive outlet is for insecticides. For many years bollweevils—arch enemies of southern cotton growers—have been a powerful factor in the demand for arsenic, but during 1934 grasshoppers afforded the main stimulant to the arsenic trade. To combat this menace in drought-ridden States of the West and Midwest, the Bureau of Entomology of the Department of Agriculture purchased nearly 4,000 short tons of crude white arsenic and a relatively small quantity of sodium arsenite. The crude arsenic was mixed with wheat bran, sawdust, and molasses at mills, chiefly in the Minneapolis area, and the bait mixture furnished to State and county agencies in 18 States for free distribution to farmers. Sodium arsenite was used by the Bureau of Entomology in other grasshopper-bait mixtures and will be employed during 1935 in preference to crude arsenic, as the bait can be prepared locally instead of at mixing mills.

More and more attention is being devoted to the use of arsenicals in spray mixtures for protecting fruit trees from the codling moth and other harmful pests. The ideal insecticide is one that effectively kills the insect with the minimum of damage to foliage and leaves a residue which is readily removed by ordinary rainfall or simple washing. Numerous reports covering results of research by various agricultural agencies have appeared within the past year or two. P. J. Chapman and others [2] found that calcium and lead arsenates are approximately equal (weight basis) in efficiency for the plum curculio, rose leaf beetle, rose chafer, and apple maggot, but that lead arsenate gives better control of the codling moth and green fruit worm. Marshall and Groves [3] report that a spray mixture of lead arsenate and herring oil was more effective than mixtures of zinc arsenate, manganese arsenate, or calcium arsenate with oil for codling-moth control, and Hough [4] has also cited advantages of using lead arsenate for that purpose.

Continued attention was devoted to the problem of spray-residue removal at various State agricultural agencies. The Nation-wide scope of the problem is indicated by the following references:

California.—Tucker, R. P. Notes on the Lead Arsenates. California State Dept. Agric. Monthly Bull. 23, 1934, pp. 141–145.

Connecticut.—Garman, Philip. Tests with Lead Arsenate Substitutes. Connecticut Pomological Soc. Proc. 43d Ann. Meeting, 1933, pp. 70–80.

Florida.—Miller, Ralph L. and others. The Effect of Lead Arsenate Insecticides on Citrus Fruits. Proc. Florida State Hort. Soc., 1933, pp. 57–63.

Massachusetts.—Bourne, Arthur I. Spray-Residue Problem. Massachusetts Agric. Exper. Sta. Bull. 305 (Ann. Rept., 1933), pp. 31–32.

New Jersey.—McLean, Harry C. and Weber, Albert L. How the State of New Jersey Meets the Spray-residue Situation. New Jersey Agric. Exper. Sta., J Series (unnumbered), 1933, pp. 1–8.

——— Spray-residue Removal from Fruits and Vegetables. New Jersey Agric. Exper. Sta. Extension Bull. 122, 1934, pp. 1–7.

New York.—Webster, R. L. The Status of Codling-moth Control with Insecticides. New York State Hort. Soc. Proc. 79th Ann. Meeting, 1934, pp. 33–46.

Pentzer, W. T. Methods of Spray-residue Removal. New York State Hort. Soc. Proc. 79th Ann. Meeting, 1934, pp. 48–54.

Oklahoma.—Whitehead, F. E. Effect of Arsenic, as Used in Poisoning Grasshoppers, Upon Birds. Oklahoma Agric. Exper. Sta. Bull. 218, 1934, pp. 3–54.

Oregon.—Robinson, R. H. and Hatch, M. B. Removal of Lead and Arsenic Spray from Pears and Apples. Oregon Agric. Exper. Sta. Bull. 317, 1933, 15 pp.

Pennsylvania.—Worthley, H. N. Results of Codling-moth Experiments (in Pennsylvania) in 1933. Pennsylvania State Hort. Assoc. Proc. 75th Ann. Meeting; Pennsylvania State Hort. Assoc. News, vol. 11, no. 1, 1934, pp. 38–40.

Hodgkiss, H. E. Codling Moth and Rosy Aphis Suppression. Pennsylvania State Hort. Assoc. Proc. 75th Ann. Meeting; Pennsylvania State Hort. Assoc. News, vol. 11, no. 1, 1934, pp. 50–60.

Virginia.—Farley, Arthur J. Removing Spray Residues. State Hort. Soc. Proc. 38th Ann. Meeting; Virginia Fruit, vol. 22, no. 1, 1934, pp. 133–141.

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[2] Chapman, P. J., and others, Some Comparisons Between Calcium Arsenate and Lead Arsenate as General Insecticides for Apple: Jour. Econ. Entomol., vol. 27, 1934, pp. 421–431.

[3] Marshall, J., and Groves, Kermit, Non-Lead Sprays for Codling Moth: Washington State Hort. Assoc., Proc. 29th Ann. Meeting, 1933, pp. 39–60.

[4] Hough, W. S., Codling-Moth Control: State Hort. Soc., Proc. 38th Ann. Meeting; Virginia Fruit, vol. 22, no. 1, 1934, pp. 165–171.

Washington.—Overholser, E. L., and others. Spray-residue Removal in 1933. Washington State Hort. Assoc. Proc. 29th Ann. Meeting, 1933, pp. 74–78.

Smith, Edwin, and others. The Removal of Lead, Arsenic and Fluorine Residues from Apples. Washington State Hort. Assoc. Proc. 29th Ann. Meeting, 1933, pp. 86–96.

Relatively small quantities of arsenic are utilized in the form of metal, the principal outlets in this field being in the manufacture of shot and in lead-base alloys for battery grids, bearings, electric cable sheathing, and other products. Under some circumstances it is desirable to take advantage of the presence of small quantities of arsenic in copper. The properties and commercial applications of arsenical copper have been described by Gregg,[5] who notes that material containing 0.5 percent arsenic is stronger at 350° C. than is the arsenic-free material and that arsenic improves copper used in locomotive fireboxes. Other desirable qualities imparted by the presence of small percentages of arsenic include improved rolling properties and strength, higher annealing temperatures, and resistance to wear and to principal corrosive agents.

Although the glass industry takes only a few hundred tons of white arsenic annually it provides a steady source of demand. The properties and uses of arsenic as a refining agent, decolorizer, and opacifier are discussed in a recent article in Glass Industry.[6] A granulated arsenic trioxide (8 percent through 120-mesh, one third over 40-mesh) has been on the market for a year or two for glass making at a premium of ½ cent over ordinary high-grade white arsenic; in the latter part of 1934 material from Belgium was offered at 3⅝ cents or ⅛ cent above the prevailing market price.

Imports.—In 1934 imports of white arsenic for consumption rose to an all-time high—14,110 short tons valued at $707,709—compared with 10,583 short tons valued at $512,542 in 1933. Mexico as usual was the principal source of the foreign arsenic consumed in this country, and in 1934 entries from that country into the United States represented more than 60 percent of the total imports. France, an insignificant factor until 1933, furnished nearly 25 percent of the total quantity of imports for consumption in 1934.

Imports of arsenical compounds other than white arsenic are shown in the table of salient statistics. Calcium arsenate and sheep dip never are imported in very large tonnages; but the imports of sheep dip, which totaled 237,037 pounds in 1934, were the largest on record, and those of calcium arsenate likewise increased.

[5] Gregg, J. L., Arsenical and Argentiferous Copper: Am. Chem. Soc. Monograph, Chem. Cat. Co., 1934, 189 pp.

[6] Glass Industry, The Use of Arsenic in Glass Batches: Vol. 16, no. 2, February 1935, pp. 49–50.

White arsenic imported into the United States, 1930–34, by countries [1]

Country	1930		1931		1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Australia					6	$380	452	$23,001	39	$1,494
Belgium	400	$27,130	321	$23,203	278	18,698	239	13,760	11	705
Canada	1,109	81,543	1,532	114,324	841	60,462	457	31,404	672	44,710
France	27	1,761	17	1,079	537	16,194	3,810	113,606	3,338	94,859
Germany	11	909	66	4,626	252	15,927	219	12,482	35	3,845
Japan	674	27,870	1,546	66,324	1,643	63,659	1,337	60,397	1,311	61,126
Mexico	8,234	585,705	4,298	241,053	3,325	182,671	4,041	256,611	8,704	500,970
Netherlands			11	859						
Sweden	325	19,500					28	1,281		
	10,780	744,418	7,791	451,468	6,882	357,991	10,583	512,542	14,110	707,709

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

Exports.—Exports of white arsenic are not recorded in official statistics, but reports of individual domestic producers indicate that sales for export, which in recent years have amounted to slightly less than 2,000 tons, rose to more than 2,700 tons.

THE INDUSTRY IN FOREIGN COUNTRIES

Brazil.—Early in 1934 a circular was issued by the Federal Ministry of Finance of Brazil [7] reducing duties on calcium arsenate and lead arsenate imported for combating insect pests attacking cotton.

Canada.—The production of white arsenic in Canada was 830 short tons valued at $56,652 in 1934, a slight increase in tonnage compared with 734 short tons valued at $56,534 in 1933, but far below normal. In no other years since 1908 has production dropped below 1,000 short tons annually. Imports of white arsenic, on the other hand, increased to an all-time record of 819 short tons valued at $41,688. Several hundred tons of other arsenicals were imported. As in former years, the white arsenic was produced at Deloro, Ontario, from the silver-cobalt ores of the Cobalt and Gowganda districts. In 1934, however, arsenical concentrates were shipped to England from Nova Scotia, and an additional source of arsenic may develop as a result of research in connection with the recovery of arsenic from the gold-bearing arsenical ores of northern Quebec.

In Alberta, increasing quantities of sodium arsenite have been employed in combating grasshoppers.[8] An initial campaign which lasted from 1921 to 1923 was successful in controlling the pests until 1931, when another outbreak occurred. In 1934, an infested area of crop land totaling 4,500,000 acres was treated with 32,000,000 pounds of bait composed of 8,500 tons of sawdust, 2,500 tons of bran, 30,000 gallons of sodium arsenite solution, 30 tons sodium silicofluoride, 11,000 gallons of paraffin oil, 2,700 pounds of molasses, and 2,000 pounds of salt.

[7] Bureau of Foreign and Domestic Commerce, Brazil Cuts Duty on Certain Arsenates: World Trade Notes on Chemicals and Allied Products, vol. 8, no. 22, May 26, 1934, p. 4.

[8] Bureau of Foreign and Domestic Commerce, Grasshopper Control in Alberta: World Trade Notes on Chemicals and Allied Products, vol. 9, no. 4, Jan. 26, 1935, p. 4.

France.—The French output of white arsenic has grown remarkably in recent years, increasing from 447 metric tons in 1920 to 3,950 metric tons in 1930 and 4,725 tons in 1931. Production figures for 1933 and 1934 are not available, but exports alone amounted to 7,247 metric tons in 1933.

Germany.—The importance of the arsenic industry in Germany is indicated by a press report [9] to the effect that arsenic mines in Reichenstein, Silesia, where gold is recovered as a byproduct, were saved from closing by agreement of the Reich Railways to use Reichenstein arsenic products in their regular campaigns against insect and animal pests along their rights-of-way.

Mexico.—The output of Mexican arsenic during 1934 was 7,860 metric tons compared with 4,697 metric tons in 1933, indicating recovery at an accelerated pace from the low point in 1932. In June it was reported that the Penoles Mining Co. was erecting an arsenic plant at its smelter at Torreon Coahuila.

Sweden.—The Boliden Mining Co.[10] (Bolidens Gruvaktiebolag) is producing about 400,000 metric tons of ore annually from its deposit in the Province of Vesterbotten, northern Sweden. The ore is a mixture of arsenopyrite, chalcopyrite, and iron pyrite, with minor amounts of other minerals containing gold, silver, lead, zinc, bismuth, and antimony, and contains an average of 1.74 percent copper, 9.1 percent arsenic, 61 grams of silver, and 20.3 grams of gold per metric ton. The gold is the main product of the enterprise, but the huge quantities of arsenic which have to be recovered concurrently are roughly equivalent to the combined arsenic output of the rest of the world. All the arsenic and part of the sulphur are removed from the ore by roasting in large 11- and 7-hearth furnaces. The smelting plant is at Rönnskär, a small peninsula jutting out into the Gulf of Bothnia 20 kilometers from Boliden. Most of the arsenic is stored in an enormous concrete warehouse, but some quantities are marketed in crude form and the remainder is refined by sublimation or by a special wet treatment.

During the last 2 years considerable quantities of Boliden arsenic are said to have been shipped for use in insecticides, especially in South Africa for combating locusts, but the stocks of arsenic available are so enormous that it has been necessary for the company to carry on intensive research to find new outlets for its material. Of particular interest are the results announced in connection with the use of arsenic in wood preservatives and in quick-setting concrete. The company claims to be able to produce a superior wood preservative and to have worked out methods of application which can be employed cheaply either in the district where the timber is cut or near consuming centers.

As arsenical concrete is more resistent to sea water and humus-containing water than ordinary concrete it is especially suitable for constructions exposed to the action of water. Wooden piles in a wooden dock construction on the west coast of Sweden have been coated with arsenical concrete for protection against shipworms (*Teredo Navalis*). It was possible to use a heavy pile driver on the piles without damage to the coating 24 hours after a 1-inch to 1½-inch

[9] Mining Journal (London), German Subsidy for Arsenical Gold Mine: Vol. 186, no. 5181, Dec. 8, 1934, p. 927.
[10] Boliden Mining Co., Trade Booklet, Stockholm, 1935, 15 pp.

layer of arsenical concrete had been sprayed on them. Arsenical concrete sets so quickly that it cannot be mixed and poured in the usual way and a special cement-gun method has been worked out whereby the arsenic, water, and cement sand are combined in the nozzle immediately before spraying.

Concrete in which about 25 percent of the portland cement ordinarily employed has been replaced by arsenic will begin to set after 2 or 3 minutes, and in a few hours has approximately the same strength as would be attained by ordinary concrete in a week.

World production of arsenic ore and white arsenic, 1929–33, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country and product	1929	1930	1931	1932	1933
Algeria: Arsenate of lead:					
Gross weight	2,541	1,175	--------	--------	--------
Arsenic content	305	353	--------	--------	--------
Australia:					
New South Wales:					
Ore and concentrates [1]	2,814	6,809	3,977	(2)	2,685
White arsenic	255	809	672	495	452
Western Australia: White arsenic	--------	--------	416	1,501	1,352
Belgium-Luxemburg Economic Union: White arsenic [3]	3,717	3,111	2,502	2,045	2,579
Brazil: White arsenic	--------	--------	179	211	322
Canada:					
White arsenic	1,678	1,248	1,622	1,100	666
Arsenic content of ores and concentrates exported	694	804	--------	--------	--------
China: White arsenic	2,387	983	500	(2)	(2)
Chosen: White arsenic	--------	--------	--------	--------	153
Czechoslovakia:					
Ore:					
Gross weight	38	--------	--------	5	--------
Arsenic content	8	--------	--------	1	--------
France:					
Ore: [4]					
Gross weight	43,263	48,795	105,635	109,268	(2)
Arsenic content [5]	3,622	4,970	5,774	4,460	(2)
White arsenic	3,372	3,950	4,725	[3] 3,894	[3] 7,247
Germany:					
Ore:					
Gross weight	27,866	29,437	27,935	2,824	(2)
Arsenic content	1,756	1,858	1,850	(2)	(2)
White arsenic [3]	2,578	4,614	4,425	3,459	2,662
Great Britain:					
Ore [1]	20	--------	--------	--------	--------
White arsenic and arsenic soot	968	588	180	251	123
Greece: White arsenic	763	841	659	385	255
Japan: White arsenic	1,963	1,654	2,588	2,637	2,375
Mexico: White arsenic	12,785	9,476	7,956	3,991	4,697
Portugal:					
Ore [1]	9	(2)	(2)	(2)	(2)
White arsenic	105	176	159	59	2
Southern Rhodesia: White arsenic	52	50	--------	--------	--------
Sweden:					
Ore:					
Gross weight	22,919	24,316	54,355	198,231	373,520
Arsenic content	4,584	4,350	11,182	20,035	38,446
Turkey:					
Ore:					
Gross weight	14	55	54	306	1,906
Arsenic content	6	22	22	122	762
Union of South Africa: White arsenic	33	15	9	4	--------
United States: White arsenic (sales)	13,196	15,808	12,498	11,324	10,702
Yugoslavia: Ore [1]	--------	7	--------	--------	--------

[1] Gross weight. Arsenic content not stated.
[2] Data not available.
[3] Exports of domestic product.
[4] Includes arsenopyrites, mispickel, and realgar.
[5] In addition, arsenic contained in ores worked primarily for gold and lead is reported as follows: 1929, 410 tons; 1930, 137 tons. Data not available for later years.

RADIUM, URANIUM, AND VANADIUM

By Frank L. Hess [1]

SUMMARY OUTLINE

During 1934 the mining of radium, uranium, and vanadium ores in the United States was on a small scale, but a number of claims in Arizona, Colorado, and Utah were worked for one or all of these elements.

Most of the ores shipped contained 2 to 5 percent U_3O_8 and from 2.5 to 6 percent V_2O_5. One shipper reported that unless 5 percent V_2O_5 was present no pay was received for vanadium. The Vitro Manufacturing Co., of Pittsburgh, Pa., bought most of the ore shipped. The Colwell Manufacturing Co., of St. Paul, Minn., also bought some ore.

Salient statistics on the three metals are summarized in the following table:

Salient statistics on radium, uranium, and vanadium, 1933–34

	1933		1934	
	Quantity	Value	Quantity	Value
Production:				
Carnotite ores short tons	52	$3,099	254	$11,074
Radium contained milligrams	256	(1)	1,007	(1)
Uranium contained pounds	1,694	(1)	6,661	(1)
Vanadium contained do	2,240	(1)	12,528	(1)
Vanadium ores short tons	53	1,020	(2)	(2)
Vanadium contained pounds	1,781	(1)	(2)	(2)
Imports:				
Uranium oxide and salts of do	186,461	245,656	158,991	176,22
Radium salts grams [3]	11.6	576,026	21.97	1,082,46

[1] Figures not available.
[2] Bureau of Mines not at liberty to publish figures.
[3] Bureau of Foreign and Domestic Commerce publishes quantities as follows: 1933, 179 grains; 1934, 339 grains.

Imports.—The imports of radium were the largest recorded, but those of uranium salts, although large for such a minor commodity, were not outstanding.

[1] Figures on imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Radium and uranium salts imported for consumption in the United States, 1931–34

Class	1931		1932		1933		1934	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Radioactive substitutes	(1)	$267	(1)	$2,513	(1)	$74	(1)	$1,851
Radium salts grams [2]	13.41	731,204	9.14	479,028	11.6	576,026	21.97	1,082,462
Uranium oxide and salts of pounds	180,049	233,601	122,229	146,051	186,461	245,656	158,991	176,222
		965,072		627,592		821,756		1,260,535

[1] Weight not recorded.
[2] Bureau of Foreign and Domestic Commerce publishes quantities as follows: 1931, 207 grains; 1932, 141 grains; 1933, 179 grains; 1934, 339 grains.

The value of radioactive substitutes imported into the United States from the United Kingdom was $800; Czechoslovakia, $590; Switzerland, $380; Belgium, $42; and Germany, $39. Imports of radium salts were from Belgium, 317 grains (20.541 grams); Canada, 12 grains (0.778 gram); and the United Kingdom, 10 grains (0.648 gram). "Uranium, oxide and salts of" imported from Belgium were 158,475 pounds, Canada 504 pounds, and Germany 12 pounds. Canada also shipped to the United States 7,900 pounds of uranium ore valued at $36.

During the 3 years prior to 1934 there were no imports of vanadium ores. In 1934 a considerable quantity was imported, the V_2O_5 content of which was 21.07 percent according to the Bureau of Foreign and Domestic Commerce. All imports were from Peru.

Vanadium ore (steel-hardening) imported for consumption in the United States, 1929–34 [1]

Year	Gross weight (gross tons)	Content V_2O_5 (gross tons)	Value
1929	8,714	(2)	$794,734
1930	5,168	(2)	491,633
1934	1,566	330	145,506

[1] No imports reported for 1931–33.
[2] Not recorded.

Legislation.—On February 28 a bill was introduced in the Senate by Senator James J. Davis, "to permit radium to be accepted in payment of war debts due from Belgium and to provide for the distribution of such radium" (S. 2985, 73d Cong., 2d sess.). By this bill, radium to the value of $10,000,000 would be accepted in payment of Belgium's national indebtedness to the United States. The radium was to be donated "to such institutions as in the judgment of the President are likely to provide the greatest relief to the sick by the use of such radium * * * preference shall be given to hospitals and medical clinics the resources of which are inadequate to enable them to purchase radium." The bill did not pass.

DOMESTIC PRODUCTION

Colorado.—During the year the S. W. Shattuck Chemical Co. (1805 South Bannock Street, Denver) continued mining carnotite and accompanying minerals on claims leased from the American Rare Metals Co. The claims, known as the "Ocumpaugh properties", lie along Dolores River in the McIntyre district, western San Miguel County. The mill, a part of the property, was remodeled in the fall.

The ores mined were shipped to the company experimental plant in Denver for treatment. A commercial radium plant was erected in the fall, and about the close of the year the company was ready to start work on a larger scale. Past production included dilute radium salts, sodium uranate, uranium nitrate, uranium acetate, and vanadium compounds. It has been estimated by the company that the production of a gram of radium requires the equivalent of 15 men working for a year.

Others who mined and sold carnotite ores in Colorado during the year were T. C. Brammeier, Naturita; W. C. Martin, W. G. Gibson, A. E. Riddle, and J. B. Riddle, Paradox; Sullivan Bros., Nucla; M. E. O'Neill, Bull Pen Canyon (P. O., Summit Point, Utah), and J. W. Lewis, Gateway.

The United States Vanadium Corporation (30 E. Forty-second Street, New York), which formerly operated a vanadium mine on East Rifle Creek 11 miles northeast of Rifle, prepared to mine carnotite ores on properties formerly owned by the Standard Chemical Co. and on other properties in the vicinity.

A salt works, using brine from wells, was established at Bedrock in Paradox Valley, and the mill at Club Ranch on the San Miguel River below Naturita was overhauled. Considerable work was done on the road from Club Ranch down the San Miguel and Dolores Rivers to Gateway to connect with a highway to Grand Junction.

It is reported that the Western Vanadium Co. (Denver) has done some work on the Radium King group of claims on Carpenter's Flats, Montrose County.

Utah.—H. W. Balsley (Yellow Circle Mining Co., Moab), mined ore from claims owned by the company in La Sal Mountains, 16 miles southeast of Moab; he also acted as agent for the Vitro Manufacturing Co. of Canonsburg, near Pittsburgh, Pa., and purchased carnotite ores for it.

Frank Silvey (Summit Point) mined a small quantity of ore. Shumway Bros. (Blanding) mined some ore from their claims 12 miles west of Blanding, but no shipmints were made. The ore is said to be of high grade, 6.67 percent U_3O_8 and 35 percent V_2O_5. The vanadium is largely in the red mineral, hewettite, a calcium vanadate, $CaO.3V_2O_5.9H_2O$. J. W. Lewis shipped some vanadium-bearing sandstone from Grand County.

FOREIGN COUNTRIES

Bulgaria.—Announcement was made of the discovery of "very extensive deposits" of autunite (calcium uranium phosphate) near the village of Streltscha, Bulgaria, although it is said that work on the deposits began 2 years ago.[2]

[2] Chemical Age, London, Note: Vol. 30, Apr. 28, 1934, p. 367.

Canada.—"Canada Week by Week", a clip sheet published by the Canadian Government, in the issue of February 23, 1935, gives the following account of radium operations at Great Bear Lake, Mackenzie district, N. W. T. It is evident that the property described is the Eldorado Gold Mines, Ltd., though the company is not mentioned by name:

Bringing radium-bearing ores out of the Far North by airplane is just another example of the resourcefulness of Canadian industry. With the mine at Great Bear Lake, in the sub-Arctic section of the Northwest Territories, and the refinery at Port Hope, Ontario, nearly 4,000 miles apart, the task of bringing the ore from the mine to the refinery presented a difficult situation. Due to the late break-up last year, which seriously delayed transportation, it was near the close of navigation before a supply of ore for the Port Hope refinery could be shipped from the mine. To avoid such a recurrence in future a large freight airplane has been acquired which will be used to transport mill concentrates to the railhead at Waterways, Alberta, during the winter months, and thus ensure an adequate supply of ore for the refinery.

During 1934 shipments of both high-grade crude ore and concentrates totaled 83 tons, and the company reported a production of 6.1 grams of radium during the year. This was extracted from 61 tons of ore, giving an average content of one gram of radium to 10 tons of ore.

With transportation difficulties satisfactorily solved, Canada's radium industry is now firmly established. During the year, 750 tons of freight were shipped to the property, including the necessary machinery to increase the concentrator capacity to 75 tons of ore daily. Successful underground mine development work during 1934 has resulted in the decision to expand refinery operations, whereby the present capacity of one half ton of concentrate daily will be doubled.

The production of uranium salts is an important part of the refinery operations, and production to date of such compounds, chiefly orange and yellow sodium uranate, and black oxide, has totaled 60,000 pounds. In addition, much of the ore is rich in silver, of which a total of 30,500 ounces has been recovered as a byproduct of refinery operation.

A little pitchblende has been found on several other properties at Great Bear Lake, but so far none has proved of commercial value. It is reported that one company mined a considerable quantity of black oxides of iron under the impression that the mass was pitchblende.

In the spring of 1934 pitchblende was found at Hottah Lake, 100 miles south of Great Bear Lake. According to a letter from Hugh S. Spence, dated May 17, 1934, samples carried as much as 35 percent U_3O_8 and a great deal of later specular hematite. By fall no commercial quantity of the pitchblende had been found.

Katanga.—No direct news has been received concerning the Katanga radium deposits, but the Rhodesian Mining Journal (vol. 8, July 1934, p. 336) which maintains more or less close touch with Katangan mining conditions says:

The reserves of uranium ore in the Belgian Congo are sufficient to assure the predominance of that country in the production of radium for many years to come.

South Australia.—Efforts continue to exploit the uranium deposits on Mount Painter in the desert north of the railroad to Broken Hill. An item [3] says:

The Australian Radium Corporation, which has leases at Mount Paynter, has been reconstructed with a capital of £50,000 shares of which 10,000 fully paid shares will be allotted to shareholders in the old company. It is proposed that 6 months should be devoted to developing the leases with the object of extracting eight tons of 10 percent uranium oxide concentrates, containing radium to the value of about £2,304. It is estimated that the concentrates can be sold overseas at £288 a ton. Mr. F. F. Marcard has been engaged to supervise operations.

[3] Chemical Engineering and Mining Review, vol. 26, June 5, 1934, p. 366.

U. S. S. R. (Russia).—Russia's Rare Metals Works in Moscow have made vanadium compounds for catalytic use. The vanadium is a byproduct of radium isolated from tyuyamunite (a vanadate of lime and uranium) ore mined at Tyuya Muyun, Ferghana, Russian Turkestan. Efforts have been made to develop other sources of vanadium, and at the Kerch Steel Works in the Crimea, where a phosphatic iron ore carrying 0.11 to 0.17 percent V_2O_5 is used, vanadium is saved from the slag.[4]

A new deposit of uranium ore claimed to carry 3 percent U_3O_8 is said to have been discovered 100 km northeast of Ferghana, Turkestan, at Taboshar. Uranium deposits have been known at Ferghana for a good many years.[5]

The discovery has been reported by Soviet geologists of a large deposit of uranium in the Caucasus which is said to carry 3 percent U_3O_8 and to be larger than Tyuya Muyun and Taboshar. The ores are believed to resemble the carnotite ores of the United States.[6]

It is reported that some radium has been extracted from water accompanying the petroleum in the south of Russia.

[4] Suslov, B. M., Ferrovanadium from 0.1-Percent Ore: Metal Progress, vol. 23, June 1933, p. 47.
[5] Kohl, E., U. S. S. R. Uranium Lagerstätten: Chronik Jahrg., vol. 21, 1934, p. 122.
[6] U. S. Bureau of Foreign and Domestic Commerce, Russian Econ. Notes: Sept. 15, 1934, p. 13.

PLATINUM AND ALLIED METALS [1]

By H. W. Davis

SUMMARY OUTLINE

Although platinum occurs over a wide area in Alaska, California, and Oregon (the chief producing localities of this country) the proportion of the platinum metals present usually is small, and the deposits could not be worked profitably if it were not for the gold content. The quantity of platinum metals recovered annually from these placer deposits averaged about 300 ounces during the decade 1924–33 and was almost negligible in the world supply. Considerable quantities—775 ounces in 1924, 2,842 ounces in 1925, 3,330 ounces in 1926, and 108 ounces in 1927—of palladium formerly were recovered from domestic palladium-bearing copper ore, but none has been recovered since 1927. Much larger quantities of platinum metals are obtained in the United States as byproducts of gold and other metals (about 7,000 ounces annually during the 10 years 1924–33), but the total output from domestic sources has small importance compared with domestic consumption. The United States is, however, an important contributor to the world supply of refined new metals, as it has furnished about 50,000 ounces annually for 1924–33. The bulk of this output comes from crude platinum imported from foreign sources, notably Colombia. In addition, this country has supplied about 46,000 ounces of secondary platinum metals annually for the period 1924–33.

It is estimated that the world's known workable deposits of platinum can supply annually a production of 235,000 to 255,000 ounces of new platinum and 70,000 ounces of palladium; the ability of the various producing countries to contribute to such an annual supply was indicated in Minerals Yearbook, 1934, page 508.

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Salient statistics of platinum and allied metals in the United States, 1933–34, in troy ounces

	1933	1934		1933	1934
Production:			Stocks in hands of refiners, Dec. 31:		
Crude platinum from placers	1,266	3,720	Platinum	41,204	41,370
			Palladium	20,581	26,377
New metals:			Other	15,237	16,174
Platinum	[1] 48,581	[1] 43,392		77,022	83,921
Palladium	942	1,471			
Other	2,016	2,411	Imports for consumption:		
	51,539	47,274	Platinum	111,284	133,299
			Palladium	37,790	29,954
Secondary metals:			Other	13,007	11,059
Platinum	35,073	35,494		162,081	174,312
Palladium	4,814	5,606			
Other	1,475	2,656	Exports:		
	41,362	43,756	Unmanufactured	23,686	1,897
			Manufactures (except jewelry)	1,323	759

[1] In 1933 includes 1,298 ounces of new platinum from domestic sources, comprising 248 ounces derived from crude placer platinum and 1,050 ounces obtained from domestic gold and copper ores as a byproduct of refining; in 1934 includes 2,976 ounces of new platinum from domestic sources, comprising 1,914 ounces derived from crude placer platinum and 1,062 ounces obtained from domestic gold and copper ores as a byproduct of refining.

CRUDE PLATINUM

Production.—Mine returns for 1934 indicate a production of 3,101 troy ounces of crude platinum in Alaska, 491 ounces in California, and 128 ounces in Oregon—a total of 3,730 ounces (1,266 ounces in 1933). The greater part of the production in Alaska came from placers in the Goodnews Bay district south of the mouth of the Kuskokwim River, but small quantities were recovered in placer-gold mining in the Koyuk district, Seward Peninsula, and in reworking the tailings from earlier lode-mining operations in the Ketchikan district, Kasaan Peninsula. In California most of the platinum produced was a byproduct of dredges working the gold placers in Merced, Sacramento, Stanislaus, and Yuba Counties. The production in Oregon came mainly from the ocean beach near Cape Blanco in Curry County.

Many gold and copper ores in the United States contain comparatively small quantities of platinum. These ores furnish the greater part of the new platinum recovered annually from domestic sources. In 1934, 1,062 ounces of platinum were recovered as a byproduct of refining gold and copper ores compared with 1,050 ounces in 1933.

Purchases.—Platinum refiners in the United States reported purchases of domestic crude platinum from the following sources in 1934: Alaska, 2,190 ounces; California, 361 ounces; Oregon, 132 ounces; Washington, 1 ounce; and unspecified, 137 ounces—a total of 2,821 ounces (508 ounces in 1933). Refiners in the United States also reported purchases of 51,810 ounces (58,897 ounces in 1933) of foreign crude platinum in 1934—12 ounces from Canada, 47,871 ounces from Colombia, 3,595 ounces from South Africa, and 332 ounces unspecified.

Markets and prices.—Returns received from the sale of crude platinum are disappointing to miners who are unaware that quotations usually refer not to the price of the metallic content of crude platinum but to that of the pure metals which have been subjected to treatment costs.

33 pages missing

Selenium sold by producers in the United States, 1930–34

Year	Sales		
	Pounds	Value	
		Total	Average
1930	278,309	$454,911	$1.63
1931	292,234	386,255	1.32
1932	244,123	(1)	(1)
1933	331,963	(1)	(1)
1934	319,838	(1)	(1)

[1] Bureau of Mines not at liberty to publish figures.

Only a few years ago selenium was considered something of a curiosity, interesting chiefly because of its unusual property of changing electrical conductivity when exposed to light. The first experiments in recovering the element by American copper refiners were begun about 1905, and many years before that there was a quasi-commercial production of selenium dioxide from lead-chamber sludge by sulphuric acid manufacturers. Small amounts were employed in ruby glass and red enamelware, but in 1910 the output of selenium in the United States was reported as 10,674 pounds valued at $35,000, the price ranging between $3 and $5 a pound, and in the same year Germany reported an output of about 1,650 pounds. Selenium began to be used experimentally in Europe for decolorizing glass about this time, and beginning about 1914 the wartime shortage of high-grade manganese ore tended to stimulate the employment of selenium for this purpose. It was not until 1922, however, that domestic sales of selenium began consistently to exceed 100,000 pounds a year. Within the next 4 years demand doubled, and domestic sales rose in 1928 to a maximum of 362,697 pounds valued at $607,382. Production reached a maximum of 516,298 pounds in 1929, and even in 1930 the output of selenium was not curtailed as much as that of copper. Sales of selenium, however, failed to keep pace with production, which accordingly was curtailed in 1931 to a much greater extent than electrolytic copper production. Later figures for selenium output cannot be published, but a limit was placed upon any substantial increase while copper refineries were operating at under 30 percent of normal. On the other hand, sales of selenium, as indicated by the foregoing table, held up rather well, and the result of this combination of circumstances has been not merely to reduce stocks but actually to raise the question of a dearth of selenium supplies. Should selenium sales continue to increase faster than those of copper the domestic production of selenium, instead of being regulated by an erratic demand in the United States and abroad, henceforth will be proportional to the activity of copper refiners.

One aspect of this changing condition has been the inclusion of selenium among the elements paid for by the refineries. Formerly there was a tendency to penalize for selenium content; now it is paid for in anode muds, for example, provided the Se content exceeds 4 percent. Considerable Russian material was purchased on this basis in 1934 by plants near New York.

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Canada is becoming a very important source of selenium, which is a minor constituent of the Sudbury nickel ores, but the first Canadian recoveries (only 21,500 pounds) were made in 1931 by the Ontario Refining Co., Ltd., at Copper Cliff, Ontario. No production was reported for 1932, and in 1933 the reported output rose to 48,221 pounds valued at $70,345 (revised figures) and increased again to 73,516 pounds in 1934. In addition to the Ontario production the Montreal East plant of the Canadian Copper Refiners, Ltd., in Quebec has begun to produce; figures for 1934 are not released for publication, but preliminary reports promised a very large addition to world supply from this source alone, possibly equal to production from all other sources combined. This selenium originates in the ores of Noranda Copper Mines, Ltd.

Selenium is still produced in Germany, and a small amount in Australia and probably in Japan. In the U. S. S. R. (Russia) an additional increment was anticipated in 1934 from the Kachtym mines, and the new Rönnskär smelter in Sweden is expected to recover selenium.

Evidently all sources of selenium supply have not yet been tapped, and new production from byproduct sources doubtless will be developed. Even those concerns that do save selenium no doubt could recover larger quantities if they started at the smelter; it is probable that not more than one-half of the selenium content of the raw ore gets into the anode copper and that most of the remainder goes up the stack. Although selenium is distributed widely in the earth's crust it occurs in only small quantities. Leading authorities agree that there is more selenium than platinum in igneous rocks, but the proportion is only about that of silver, perhaps only a thousand millionths of 1 percent. Selenium has been noted in certain mineral waters. At least a dozen minerals contain 25 percent or more selenium, but no deposits are known that will yield these minerals commercially, except as minute constituents of metallic sulphide ores or of native sulphur from certain localities. A number of years ago a mine south of Marysvale, Piute County, Utah, yielded some quantities of tiemannite and onofrite, sulphoselenides of mercury; but the deposit has been reported exhausted, and no other deposits capable of furnishing selenium as a main product, or even as a major product, seem to have been found. Studies[28] of the selenium content of pyrite, clay, and associated materials showed a maximum of 250 parts per million down to only a trace of selenium in pyrite; the average of a large number of samples was 59 parts per million. Special mention may also be made of the carnotite ores of Colorado and Utah, which generally contain about 0.25 percent Se.

As noted in previous chapters of this series selenium is present in certain soils and may be carried into grass or grain; this fact created a considerable amount of unfavorable publicity in 1934. Following the announcement of the United States Bureau of Chemistry and Soils that selenium poisoning caused "blind staggers" in cattle it was discovered that some 50,000 acres of semiarid land should be withdrawn from agricultural use and that other infected areas probably would be disclosed if extensive soil surveys were undertaken. Unfortunately, these soils do not afford a promising commercial source

[28] Williams, K. T., and Byers, H. G., Occurrence of Selenium in Pyrites: Ind. and Eng. Chem. (anal. ed.), vol. 6, no. 4, July 15, 1934, pp. 296–297.

of the element, as even 15 parts per million of selenium are classed as definitely dangerous; concentrations of 3 to 5 parts per million, however, were not considered harmful for producing either food or feed.

Uses.—Although glass manufacture requisitions the bulk of selenium production the element has other uses. Selenium cells may have a much wider use as television and allied arts become perfected further and adopted more generally. Insecticides afford another outlet, and additional quantities are likely to be used for protecting metals from corrosion. Discussion among a group of English chemists [29] recently indicated that a thin film of elemental selenium was more successful against seawater spray than any paint investigated. The use of ferroselenium additions for making free-cutting rustless steels is advancing. Of scientific interest is a new thermocouple [30] of unusual efficiency and particularly suited for radiation measurements; this combination is copper selenide (Cu_2Se) and selenium.

Still another electrical use for selenium is a novel device for transforming light into electrical energy invented by C. W. Hewlett of the General Electric Co. Black disks of iron, about twice the size of a silver dollar, are coated with a thin layer of selenium, which in turn is plated with a film of platinum so thin as to be almost transparent. Four of these disks, wired to a tiny motor, develop an appreciable amount of power when held 12 inches below a 50-watt incandescent electric light. The platinum film cuts off much of the light from the selenium, but it multiplies the electric power 20 to 50 times. Other metals substituted for platinum increase the efficiency of the selenium cells but not as much as platinum does. As yet a scientific curiosity, this discovery may lead to a feasible means for harnessing sunlight.

Prices.—After remaining unchanged at $1.80 to $2 per pound for more than 4 years the New York quotation for selenium (black, powdered, 99.5 percent pure) was altered in November 1934 to $2.

During the greater part of the year the Liverpool quotation for selenium (high-grade black powder) remained at the 7s. 6d. to 7s. 8d. ($1.89–$1.93) price, which became effective in September 1933. In October a rumored shortage of selenium tended to raise the asking price to 10s. ($2.47) per pound, and in November and December the quotation was 7s. 6d. to 10s., or $1.87 to $2.50 per pound.

Imports.—Selenium and salts of selenium are brought into the United States duty free. Imports under this classification generally have been quite small, and the 17,719 pounds valued at $24,591 recorded in 1934 exceeded the amount imported in any year since 1928. Imports of selenium and selenium salts from 1930 to 1934, inclusive, have been as follows:

Selenium and selenium salts imported for consumption in the United States, 1930–34

Year	Pounds	Value	Year	Pounds	Value
1930	680	$988	1933	1,855	$2,402
1931	2,189	2,777	1934	17,719	24,591
1932	1,914	2,240			

[29] Jordan, Bond, Withby, Morgan, Downie, New, Barker, and Haygarth, An English Discussion on Paint as a Metal Preservative (Abstract of summary in German trade journal of papers presented at joint meeting of Oil and Colour Chemists' Assoc. and Chem. Eng. group of Soc. of Chem. Ind., London): Metals and Alloys, vol. 5, no. 12, December 1934, p. MA 573.

[30] Levitskaja, M., and Dlugac, V., A Selenium Compound of High Thermoelectric Power: Physikal. Berichte, vol. 15, May 15, 1934, p. 776; Metals and Alloys, vol. 5, September 1934, p. MA 457.

TANTALUM AND COLUMBIUM [31]

In 1934, 2,425 pounds of tantalum ore valued at $968 was shipped by Philip S. Hoyt from New Mexico and by Greene & Collingwood and Earl Schultz from South Dakota. In addition, 250 pounds of tantalum ore was produced but not sold by the Black Hills Keystone Corporation from South Dakota. Fansteel Products Co., Inc., North Chicago, Ill., is the leading producer of tantalum metal and since 1922 has been supplying not only this country but most of the tantalum used in Europe, although the Siemens concern in Germany has refined a portion of its requirements, and Blackwell's, Ltd., in Liverpool, has been producing ferrotantalum containing columbium for 15 years and more. Fansteel is also the only commercial supplier of columbium in the world, but the Electro Metallurgical Co., of Niagara Falls., N. Y., recently has engaged in commercial production of ferrocolumbium. As noted in previous chapters of this series the tantalum carbide activities of Fansteel and of Vanadium Alloys Steel Co. have been consolidated in the Vascoloy-Ramet Corporation, a jointly owned subsidiary which receives its tantalum raw materials from Fansteel and sells its product through the Vanadium Alloys Steel Co.

Prices.—Nominal quotations for tantalum metal, rod or sheet, after remaining at a base sheet price of $130 a kilogram gross since the end of 1930, were advanced to $143 in March 1934, but substantial discounts are allowed on volume business. The increase in the American price placed it a little more in line with the London quotation, which remained unchanged at £15 a pound ($165–$170 per kilogram) until autumn when it, too, was advanced to £17 10s. to £18 10s. ($192–$202 per kilogram), or about 35 percent higher than the American base price. Tantalum ores, of 60-percent Ta_2O_5 grade, were quoted variously at 75 cents to $2.50 a pound of Ta_2O_5 contained, according to source. Ferrocolumbium, after selling for some time at $2 was later advanced to $3 a pound.

Uses.—Even though platinum has been selling under the price of gold, tantalum is being sold extensively both here and abroad for rayon spinnerets and various kinds of chemical plant vessels and equipment. The economic field for tantalum surfaces for containers of corrosive materials (except hydrofluoric acid) appears to have been extended greatly by improved welding technique, whereby tantalum sheets worth $50 a pound but only 1/200-inch thick can be joined and used to line equipment of steel or other relatively cheap metal having suitable strength but lacking resistance to chemical attack. Details of this process have been described.[32] Composite metal plates comprising a thin sheet of tantalum autogenously attached to a base-metal backing are proposed for jewelry use (U. S. Pat. 1943853). Electrodeposition of tantalum and columbium have been discussed by Isgarischew and Prede.[33] Seamless tantalum tubes are now available in a wide range of sizes down to small-bore tubing for hypodermic needles. For some of the larger tubes flanged or threaded end connections may be supplied, and in addition to plain tantalum tubes tantalum-lined iron and copper tubes are produced. These tubes are convenient for

[31] Much of the information on tantalum was supplied by C. E. Stryker, Fansteel Products Co.
[32] Iron Age, Arc-Welding Tantalum Sheets for Chemical Containers: Vol. 134, no. 24, Dec. 13, 1934, p. 31.
[33] Isgarischew, N., and Prede, A. F., Die elektrolytische Abscheidung von Tantal aus wässerigen Lösungen (Electrolytic Deposition of Tantalum from Aqueous Solutions): Ztschr. Elektrochemie, vol. 40, June 1934, pp. 295–297; Metals and Alloys, vol. 5, October 1934, p. MA 486.

heating acid by indirect steam, among other uses. Hardened tantalum is beginning to be employed commercially. After treatment by a gas-absorption process the metal is suitable for many parts that must resist erosion or have greater stiffness. The use of tantalum in electronic tubes is more extensive abroad than in the United States, tantalum plates for high-power transmitting tubes being used widely in France and Germany. Columbium has a low work-function and consequently is being used as an emitter in extra-high-power electronic tubes now being produced more or less experimentally by several European companies.

The use of ferrocolumbium in stainless as well as plain chrome steels is fast becoming an established fact, and a certain amount of ferrotantalum seems to be used in steels in Europe. A heat- and corrosion-resisting steel of unusual composition has been on the German market for a year or more. Its analysis is reported as including 8 percent tantalum and 19 percent chromium, plus 1 percent silicon and 0.2 percent carbon; a little molybdenum may also be added for special purposes. This steel is claimed to show no scaling after remaining at 1,100° to 1,300° C. for 50 hours.[34]

Employment of tantalum in tantalum carbide is not its principal use, but has become a very important outlet. A number of patents and many published references attest to the growing interest in this relatively new phase of the tantalum business, but perhaps the best résumé appears in a paper by Philip McKenna presented before the American Society for the Advancement of Science and the American Chemical Society at Pittsburgh, Pa., December 29, 1934. This paper placed emphasis upon the high melting point of TaC, because, in general, substances of high melting point are also substances that resist mechanical pressure as well as destruction by heat. The melting point of tantalum carbide is given as 3,875° C., which is above the temperature of the carbon arc (3,500° C.) and higher than that of any other known compound except, perhaps, hafnium carbide. High resistance to corrosion attack is also cited as contributing to the ability of tantalum carbide tool mixtures to cut steel of previous unmachinable hardness and to retain a precision cutting edge at high speeds and for extraordinarily long periods.

Imports.—Imports of tantalum ores into the United States, all from Australia, increased in 1934 to 24,630 pounds valued at $35,441, far exceeding those of any previous year except 1932 when they jumped to 36,131 pounds valued at $51,033. In addition columbite concentrates began coming in from Nigeria in substantial quantities. This material is reported to run about 60 percent Cb_2O_5, with small percentages of Ta_2O_5 and some tin.

World supplies.—The remote Pilbarra field in Western Australia, 450 miles from rail connections, has hitherto been the only commercial source of high-grade tantalite except for occasional small shipments from British India, Africa, and the United States and specimen finds reported in South America and Europe. In British India 100 pounds of columbite valued at £4 was produced from the Monghyr district, Bihar, in 1931, but no output was reported in 1932 or 1933. Reports of new tantalum deposits in various parts of the world are rumored from time to time, and occasional samples appear but no substantial

[34] Kalpers, H., Neue Wärme- und korrosionsbeständige Stähle. (New Heat- and Corrosion-Resistant Steels): Technische Blätter deuts. Bergwerksztg., vol. 23, Aug. 6, 1933, p. 426; Metals and Alloys, vol. 5, January 1934, p. MA 2.

shipments eventuate. However, really substantial deposits of tantalite associated with cassiterite have been discovered apparently by various mining companies in the Belgian Congo. A new mineral, thoreaulite, containing 72 to 74 percent Ta_2O_5 and 20 to 22 percent SnO_2, is described [35] in connection with this new occurrence, and the relatively high tin content undoubtedly will handicap economical working. A deposit in Uganda has also been described,[36] and additional discoveries have been reported in the U. S. S. R. (Russia), this time in the Dzerul Hills, Georgia.

TELLURIUM

In 1934, as in 1933, tellurium was produced by three companies. For several years the Bureau of Mines was not at liberty to publish data covering production of tellurium, but the figures showing the quantity of tellurium sold by producers in the United States can now be released, and sales for 1930 and 1932 to 1934, inclusive, as given n the following table, show an extraordinary increase.

Tellurium sold by producers in the United States, 1930–34

Year	Sales			Year	Sales		
	Pounds	Value			Pounds	Value	
		Total	Average			Total	Average
1930	4,717	$7,996	$1.70	1933	11,980	(1)	(1)
1931	(1)	(1)	(1)	1934	21,027	(1)	(1)
1932	1,567	(1)	(1)				

1 Bureau of Mines not at liberty to publish figures.

Probably the leading development that affected tellurium in 1934 was gradual expansion in practical use of tellurium-lead. Both in England and the United States this material has passed the experimental stage and is arousing great interest in the chemical industries, particularly for equipment holding sulphuric acid. Tellurium is easily added to lead and is retained by lead up to high temperatures. Such obnoxious toxic effects as may accompany too intimate contact with tellurium compounds can be avoided by the same precautions necessary to avoid harmful lead fumes. The amount of tellurium in tellurium-lead is surprisingly small—less than 0.1 percent—but it produces marked improvement in tensile strength and corrosion resistance, refining the grain and raising the temperature of recrystallization (or at least retarding it to an extraordinary degree), enabling the material to grow harder and stronger after deformation or "working." The superiority of tellurium-lead, both in increased tensile strength and corrosion resistance, is even more pronounced at elevated temperatures, and it is for higher temperature operations (say 100° C. or over) that tellurium-lead will be particularly serviceable. A storage-battery plate of tellurium-strengthened lead, preferably with 0.05

35 Buttgenbach, H., Minerals of Belgian Congo: Ann. Soc. Belg. Bull. 56, 1932-33, pp. 327-331; Chem. Abs., vol. 28, no. 21, Nov. 10, 1934, p. 6658.
36 Combe, A. D., The Migera Tantalite Deposit: Uganda. Geol. Surv. Dept., Ann. Rept., 1933, Entebbe, 1934, p. 62.

percent tellurium and 6 percent antimony, has been patented in England.[37]

The electrical conductivity of tellurium has called for some additional study, particularly as regards the effect of small amounts of impurities.[38] Of possible commercial interest is a Canadian patent that covers the use of tellurium as resistance metal for electrical refrigerators, marking recognition by electrical engineers and instrument makers of the practical value of the high negative coefficient of electrical resistance characteristic of this metal.[39] Other uses of tellurium are in the Tainton process of zinc refining, in rubber compounding, and (as chloride) for dipping silverware to obtain a dark finish. Tellurium is described by a leading cable-maker as "the best element for processing rubber to make a tough compound * * * it improves the rubber, toughens it, enables the jacket to resist abrasion, and greatly increases the life of the cable."

Prices.—New York quotations for tellurium have remained nominally unchanged at $2 a pound for several years; in fact, since the element began to have real commercial applications. In London, however, the previous quotation of 15s. to 16s. ($3.75 to $4) a pound was advanced to 17s. 6d. ($4.32) in October 1934 (for minimum 14-pound lots, duty paid); these figures, however, are purely nominal, as large buyers are said to obtain the material at substantially lower prices, probably comparable to those quoted in the United States, which is undoubtedly the largest producer although the copper refinery at Copper Cliff, Ontario, began to recover tellurium in 1934 and refineries in other countries may be expected to do likewise when and if demand expands to sufficiently large proportions.

Imports.—Domestic supplies of tellurium still potentially greatly exceed actual demand, and exports are made to Europe; although statistics are lacking, imports of tellurium may be considered insignificant or nonexistent.

The industry in foreign countries.—The United States is probably by far the largest producer of tellurium, but Germany and other European smelting countries likewise are paying increasing attention to recovery of the element. In Canada, tellurium is produced at Copper Cliff, Ontario, as a byproduct in the refining of the nickel-copper ores; the plant began operations in October 1934, and 1,110 pounds of tellurium were sold during the year.

TITANIUM

In 1934 ilmenite and rutile were produced by the American Rutile Corporation in Nelson County, Va., and the Titanium Corporation of America in Hot Springs County, Ark., and ilmenite was produced by the Southern Mineral Products Corporation in Amherst County, Va. The Bureau of Mines is not at liberty to publish production figures, but the total output was substantially greater than in recent years. Some of the 1934 production went into stock. Shipments of ilmenite were equivalent to only about 25 percent of the reported output, but more than 70 percent of the rutile output was sold in 1934.

[37] Singleton, William, and others and Goodlass Wall & Lead Industries, Ltd.: British Patent 411524, June 8, 1934.

[38] Cartwright, C. H., and Haberfeld, M., Conductivity of Tellurium: Nature, vol. 134, no. 3382, Aug. 25, 1934, p. 287.

[39] Chemistry and Industry (London), Selenium and Tellurium: Their Properties and Uses: Vol. 53, no. 28, July 13, 1934, pp. 616-617.

The principal use of titanium continues to be in the manufacture of pigments. The titanium pigments—pure titanium dioxide, titanium-barium pigment, and titanium-calcium pigment—have been improved and perfected steadily but no material change was made in methods of manufacture, composition, or pigment characteristics during 1934. The Titanium Pigment Co. (subsidiary of the National Lead Co.) made several improvements in its St. Louis factory and was constructing a large new plant at eastern seaboard, the site finally selected being at Sayreville, N. J. This new plant is reputed to cost $4,300,000 and will probably have a daily capacity of 30 tons and employ 200 persons. Du Pont's subsidiary, Krebs Pigment & Color Corporation, is expanding its productive capacity and a further increase in the national total will result from the construction of still another new plant at Baltimore, which will be operated by the American Zirconium Corporation, a jointly owned subsidiary of the Glidden Co. and the Metal & Thermit Corporation. During 1934 it was estimated that 32,000 tons of titanium dioxide was produced in this country.

Ferrotitanium and the titanium alloys are produced in the United States by three companies, the Titanium Alloy Manufacturing Co., with plant at Niagara Falls, N. Y. (ferrocarbon and low-carbon grades), the Vanadium Corporation of America, with plants at Niagara Falls, N. Y. (ferrocarbon grades), and Bridgeville, Pa. (low-carbon grades); and the Metal & Thermit Corporation, with plant at Jersey City, N. J. (carbide-free grades). Substantial increases in sales were reported again in 1934, but figures cannot be published without revealing confidential information.

Metallurgical uses of titanium as yet have not accounted for more than a rather small percentage of the consumption of the element but nevertheless are important and growing more so. Recently its use in the alloy field has tended sharply upward. Even 3 or 4 years ago the role of titanium in steel manufacture was mainly that of deoxidizer and general scavenger, but by proper furnace technique it can now be employed for its alloying effect. The property of titanium chiefly responsible for its expanding use today as an alloying element in steel is its strong affinity for carbon, coupled with the comparatively low solubility of titanium carbide in solid steel. Carbon is undesirable in some steels, especially chrome-nickel stainless steels, but is both difficult and expensive to keep out. Often it may be simpler and more economical to neutralize its action by adding a little free titanium. This action of titanium not only avoids unduly prolonged furnace treatment to remove carbon but also permits the use of somewhat higher-carbon grades of ferrochrome and other alloys. By holding the titanium content at 5 to 7 times the carbon content, thereby in effect eliminating carbon from the picture, resistance to corrosion—particularly intergranular corrosion—is much improved and (another advantage) the steel is softer and machinable. The increased workability imparted by titanium is due to the elimination of age-hardening effects, but titanium itself may produce age-hardening if a considerable excess is added over that required for carbide control. In cast iron titanium closes the grain and, curiously enough, acts as a graphitizer. Recent work on titanium additions to nonferrous alloys, particularly copper and aluminum alloys, is expected to result in marked expansion in the use of this element in those fields.

A new high-speed steel has been patented recently by Arthur F. Braid, of the Metal & Thermit Corporation (U. S. Patent 1955529), which contains titanium instead of vanadium. This is a regular 18-percent tungsten, 4-percent chromium combination with 1.0 to 1.5 percent titanium replacing the more expensive vanadium. Titanium is entering more and more as a minor constituent of alloys. Other patent specifications relate to various chrome-steel combinations, magnet steels, and a group of cemented-carbide compositions containing substantial amounts of titanium carbide. In connection with the possible extensive use of titanium in aluminum alloys it may be mentioned that certain of these alloys can be made directly without addition of special alloys, as titanium can be reduced from raw ore or titaniferous materials in the same bath with aluminum itself.

Titanium dioxide has other uses than in paints and paper fillers. Recently it has been advocated for use in vanishing creams and allied toilet preparations and for reducing the luster of rayon (Dreyfus process), as well as more extensively in enamels and sundry other ceramic products. New patents covering methods for manufacturing titanium pigments continue to appear. Preparation of a synthetic rutile (instead of anatase) by fusing titanium dioxide for 1 hour in a caustic soda melt at 700° C. is described by Rhodes (U. S. Patent 1922328) and Richter devised a process (U. S. Patent 1947226) for making titanium dioxide or purifying rutile by a caustic soda treatment. A 1933 patent (U. S. Patent 1929521) of the Titanium Pigment Co. covers treatment of rutile by heating with sodium bisulphate or carbonate of potash to form an acid soluble alkali metal titanate as a preliminary to pigment manufacture. Two other 1933 patents (U. S. Patents 1931380–1931381) issued to Krebs Pigment & Color Corporation are of interest, inasmuch as they start with titanium tetrachloride.

Prices.—No changes in prices of leading brands of titanium pigments were made in 1934. For calcium- and barium-base pigments, in bags, 6 cents per pound was asked in carlots with ¼ cent advance for shipments under 20 tons. For pure titanium dioxide, in barrels, the carlot rate was still 17 cents, rising on a sliding scale to 18½ cents per pound on l. c. l. shipments, according to quantity. Differentials for Pacific coast deliveries averaged about ¼ cent a pound.

The contract price for standard ferrocarbon-titanium, containing 15 to 18 percent titanium and 6 to 8 percent carbon, remained at $137.50 per short ton. From 1910 to 1928 the price of this alloy was held unchanged at $200 a ton, but it was reduced to $160 in 1929, to $150 in 1930, and to $137.50 in 1931, where it has subsequently remained. London quotations likewise were continued at the same rate as in the latter part of 1933, small-lot quotations being £43 ($217) a long ton. In the United States the carbide-free alloys were quoted at 35 cents per pound of alloy for the standard 25-percent grade and $1.37 per pound of contained titanium for the new 40-percent grade; the London quotation for 23- to 25-percent "carbon-free" alloy remained at 9d. per pound.

Imports.—The imports of ilmenite, after setting new records year after year, suddenly jumped in 1934 to 71,710 long tons valued at $356,208 compared with 38,610 tons valued at $196,211 in 1933. Whereas the steady increases reported in previous years doubtless afforded a rough index of the rapidly growing output of titanium pigments in the United States the 1934 figures represent a considerable amount of material that went into storage piles in anticipation of enlarged production along the Atlantic seaboard. In recent years the total importation has come from British India.

Rutile imports likewise increased sharply, rising to 309,221 pounds valued at $7,350 compared with 157,658 pounds valued at $3,737 in 1933. The average value of these imports, all from Brazil, was under 3 cents per pound, whereas when the imports came from Norway the average foreign market value was reported several times larger; in 1931, for example, it exceeded 9 cents, and in 1930 it was over 15 cents.

Imports of ferrotitanium and other titanium alloys, mostly from Italy and Great Britain, are insignificant, amounting in 1934 to only 3,240 pounds valued at $434 (all from the United Kingdom).

Titanium ores imported for consumption in the United States, 1929–34

Year	Ilmenite		Rutile	
	Long tons	Value	Pounds	Value
1929	22,386	$104,887	11,200	$1,463
1930	22,298	150,466	6,720	974
1931	29,857	144,951	2,000	189
1932	33,491	231,652	176,395	4,508
1933	38,610	196,211	157,658	3,737
1934	71,710	356,208	309,221	7,350

THE INDUSTRY IN FOREIGN COUNTRIES

Australia.[40]—Plans for development of Byron Bay deposits of black sand include possible production of rutile and ilmenite as well as zirconium minerals. These deposits, evidently extensive, are situated in New South Wales a little over 100 miles south of Brisbane and have been worked spasmodically for tin and gold, but a new company, Zircon Rutile, Ltd., has been organized to erect a plant capable of treating 15,000 to 20,000 tons of these sands annually. A published analysis indicates an extraordinary degree of natural concentration, showing 64 percent zircon, 18 percent rutile, 9 percent ilmenite, 4 percent cassiterite, 3 percent monazite, and only 2 percent waste. The treatment method is reported to start with "flotation" of the zircon, followed by magnetic separation of the residue. Obviously, zircon is the principal object of this enterprise and preliminary estimates place operating costs at £2 5s. 3d. per ton of zircon, which it is hoped can be sold at £8 a ton at a rate of 7,500 tons a year, indicating an annual profit of £13,000 on the basis of an initial investment of around £24,500.

British India.—The Travancore beach sands were worked for monazite as early as 1911, but it was not until 1922 that ilmenite was saved and exported. Recently ilmenite has become the main product, and monazite is retreating to decidedly minor importance, production of the titanium mineral having increased steadily except for a slight set-back in 1933 which, if one may judge from imports of Indian ilmenite into the United States, was overwhelmingly off-set by an extraordinary increase in 1934. Zircon also accompanies the ilmenite; it, too, has become increasingly important, although on a more moder-

[40] Chemical Engineering and Mining Review, Zircon and Rutile from Black Sands: Vol. 26, no. 310, Melbourne, July 5, 1934, p. 388.

ate scale; production of this mineral rose in 1933 to 603 tons valued at £3,018 compared with 490.6 tons valued at £3,805 in 1932. The average value of the ilmenite production during the last year or two has been £1 a long ton, and the TiO_2 content has been well over 52 percent; these two factors doubtless explain the fact that Indian ore virtually has displaced all other water-borne ilmenite from world trade.

Canada.—Shipments of titanium ore in Canada during 1934 totaled 2,023 short tons valued at $14,161, all of which came from the Baie St. Paul deposits in Quebec and was exported to the United States. No production was reported in 1933. Consumption of titanium white by the Canadian paint industry is increasing, amounting to 1,061,249 pounds valued at $128,969 in 1933 compared with 745,207 pounds valued at $89,761 in 1931.[41] Titanite or sphene, the calcium-titanium-silicate mineral, has never served any known industrial purpose, although it contains about 40 percent TiO_2. It is interesting to record, therefore, that about 40 tons of this material was mined in 1934 with a view to finding uses for it. The mineral came from the township of North Crosby, Leeds County, Ontario, where it occurs in 2-foot crystals in a granite pegmatite dike.

France.[42]—Certain volcanic rocks in the Central Massif and in the Alps contain titanium minerals, but no workable deposits of ilmenite or rutile have been discovered. Attention is directed, however, to the titanium dioxide content of French bauxites, which ranges from 2.5 to 4 percent and averages 3.25 percent. This concentrates in the red mud, a typical analysis of which shows—

	Percent		Percent
Al_2O_3	14 to 16	TiO_2	9 to 12
Fe_2O_3	52 to 54	Ignition loss	10 to 12
SiO_2	10 to 11		

It is already proposed to utilize these red muds for making pigments; they are first washed with sulphuric acid to remove the residual caustic soda which would saponify oil, and then calcined. The titanium dioxide in the final product may contribute to its high covering power. This resource, formerly not utilized, may prove a source of 15,000 tons of titanium oxide annually on the basis of 500,000 tons bauxite consumption.

Germany.—Titanium pigments are produced in Germany by the Titan-Gesellschaft m. b. H., an I. G. subsidiary, at Leverkusen near Cologne. Production data and even accurate export figures are not available, but it is known that Germany is one of the four leading sources of these pigments and that exports in 1934 tended to run ahead of those of the previous year.

United Kingdom.—In 1933 the National Titanium Pigments, Ltd., a subsidiary of B. Laporte, Ltd., opened a titanium-pigment factory at Luton, and in 1934 another factory (begun on Aug. 30, 1933) was completed and commenced production at Billingham, Stockton-on-Tees, Durham. The new concern has a cooperative arrangement with the National Lead Co. of the United States and is jointly owned by the Imperial Smelting Corporation, Ltd., Imperial Chemical Industries, Ltd., and Goodlass Wall & Lead Industries, Ltd.

[41] Canada Department of Trade and Commerce, Dominion Bureau of Statistics, Mineral Production of Canada (Preliminary Report): 1934, p. 24.

[42] L'Industrie Chimique, La Bauxite mineral de titane: Year 21, no. 246, Paris, July 1934, p. 490.

U. S. S. R. (Russia).—It is reported that the titanium dioxide department of the Yaroslavl white lead works came into production in February 1934; 5 tons monthly were being produced at first and the anticipated capacity is only 30 tons monthly.

World production of titanium minerals, 1933–34

[Compiled by L. M. Jones, of the Bureau of Mines]

Mineral and country	1933			1934		
	Ore produced	Content of TiO_2	Value [1]	Ore produced	Content of TiO_2	Value [1]
Ilmenite:	*Metric tons*	*Percent*		*Metric tons*	*Percent*	
Australia: Tasmania	559	(2)	$4,234	(2)	(2)	(2)
Canada (Quebec)				1,835	18–25	$14,303
India (Travancore)	44,080	54	183,810	(2)	(2)	(2)
Norway	23,213	44	149,000	(2)	(2)	(2)
Portugal	645	50	2,311	434	50	(2)
Senegal [3]	[4] 310	47	(2)	(2)	(2)	(2)
United States	(5)	(5)	(5)	(5)	(5)	(5)
Rutile:						
Brazil [3]	96	(2)	3,941	(2)	(2)	(2)
Norway [6]	56	90–93	13,500	(2)	(2)	(2)
United States	(5)	(5)	(5)	(5)	(5)	(5)

[1] Values as officially reported converted to United States currency at the annual average rate of exchange as published by the Federal Reserve Board.
[2] Data not available.
[3] Exports.
[4] Exports during first 11 months of year; complete data not yet available.
[5] Bureau of Mines not at liberty to publish figures.
[6] Concentrates.

ZIRCONIUM

No zirconium minerals have been produced in the United States since 1927, although a small quantity of zircon was recovered in 1928 from old tailings. An output of about 1,000 pounds was recorded as early as 1869, and sporadic contributions have been made at intervals during subsequent years, but the only substantial supplies obtained from domestic sources were the result of the short-lived operations of Buckman & Pritchard, Inc., who produced a considerable amount of zircon as a joint product of their ilmenite and rutile operations at Pablo Beach or Mineral City, Fla. This enterprise was abandoned in 1929 after furnishing a maximum of 3,646 short tons of zircon in 1927. Since then the fluctuating requirements of the United States have been supplied by imports, chiefly from Brazil and British India.

An ever-growing demand for zirconium has stimulated the search for new deposits, and a number of new developments have occurred during the last several years, including those in Australia and British India, which are described briefly in the section of this chapter on titanium. Of special interest in connection with an Australian project is the application of flotation as a means of separating a high-grade concentrate of zircon after, or even in advance of, magnetic treatment. An abstract of the Corbett patent specifications [43] indicates that the separation can be effected from all the ordinary constituents of a black-sand concentrate—rutile, monazite, ilmenite, garnet, quartz, kyanite, etc. The oiled-zircon particles may not float on the surface of the pulp, in which case they may be separated from unoiled minerals

[43] Corbett, Miles A., Concentrating Zircon Ores: British Patent 406018, Feb. 12, 1934; Chem. Abs., vol. 28, no. 14, July 20, 1934, pp. 4362–4363.

by treatment on shaking tables or jigs (cf. Cattermole or agglomeration process). Assuming that selective oiling of zircon is practicable, it may afford a means of rendering economical additional sources of supply from black sand deposits in various parts of the world, including the United States. Zirconium-bearing areas in Japan and in the Straits Settlements were receiving considerable attention in 1934. In certain Japanese deposits a number of rare-earth minerals, especially xenotime, are associated with zircon in notable amounts. Relatively high percentages of zircon also are said to occur in stream gravels along the coast of Kenya (Africa), representing debris from the Simba grit formations.

Zirconium is generally considered rather a rare element, and commercial deposits virtually are limited to alluvial deposits, chiefly naturally concentrated black-sand accumulations, in relatively few places in the world. It is nevertheless abundant and widely distributed, being one of the commonest accessory constituents in all classes of igneous rocks, especially the more siliceous varieties. Scientists commonly agreed that zirconium constituted about 0.02 percent (1 part in 5,000) of the earth's crust, but two German chemists, after examining analyses (by X-ray spectroscopy) of 1,175 samples of rocks, conclude that the proportion is larger. They report [44] granite contains 1 part zirconium in 3,000, volcanic rocks 1 part in 4,000, and effusive rocks 1 part in 4,500, whereas stony meteorities contained only 1 part in 12,000. The element accordingly appears to be more abundant than nickel and several times more plentiful than the so-called "common metals", copper, zinc, and lead.

Prices.—Quotations for zircon ore, 55 percent, f. o. b. Atlantic seaboard, after remaining unchanged for several years at $40 to $45 a net ton (in carloads), were advanced to $55 a ton in August 1934. Crude granular zircon, f. o. b. Suspension Bridge, New York, however remained unaltered at $70 a ton with the usual $20 differential for milled or powdered material. Zirconium dioxide and zirkite in its various forms likewise remained unchanged in price. In 1933 minor reductions were made in the price of silicon-zirconium (35 to 40 percent Zr, 47 to 52 percent Si) and zirconium ferrosilicon (12 to 15 percent Zr, 39 to 43 percent Si), but the earlier quotations were restored in March 1934, the former alloy being quoted subsequently at 14 to 15 cents a pound and the latter at $97.50 to $105 per net ton. Commercially pure zirconium powder has been nominally quoted at $7 a pound since March 1933, but this price is for small lots; for 100-pound lots the price has remained at $6.

Uses.—Zirconium metal is used in flashlight mixtures and in ammunition primers. Ferrozirconium or ferrosiliconzirconium additions to steel are advocated especially when trouble is experienced with excessive sulphur—a condition that may be more common in Europe than in the United States. Zirconium also has miscellaneous uses as an alloy constituent, generally in rather small amounts, in various nonferrous alloys, including aluminum. It may be added to spark-plug electrodes, and several sintered-carbide cutting-tool compounds include zirconium. Zirconium dioxide is a useful refractory, due to its high melting point and resistance to attack by either acids or alkalies, combined with low porosity, low thermal conductivity, low ther-

[44] Hevesy, G. von, and Würstlin, K., The Natural Occurrence of Zirconium: Ztschr. anorg. allgem. Chem. vol. 216, 1934, pp. 305–311; Chem. Abs., vol. 28, no. 11, June 10, 1934, p 3342.

mal expansion, and general durability. It has been used as protective coating for cheaper refractories, and in Germany especially it is employed for combustion tubes and in wire-wound electric furnaces. Zirconia brick are claimed to be superior to magnesite brick as regards heat saving. Zirconium compounds are used widely in ceramic industries and in foundry-mold mixtures and facings. The employment of zirconia as an opacifier was begun only about 15 years ago but has grown rapidly. Summarizing this use, Kinzie and Commons state [45] that (1) zirconia in proper combination imparts a high degree of opacity to a silicate glass, (2) the amount of solution of zirconia in glass depends largely upon the kind and amount of other constituents such as alumina, zinc oxide, lime, baryta, etc., and (3) the zirconia that goes into solution in the glass imparts increased tensile strength and compressive strength and lowers the modulus of rigidity.

Imports.—Depletion of stocks and increased consumption of zirconium-bearing raw materials are indicated by resumption of imports of zirconium ores on a fairly large scale. In only 3 years (1918, 1929, and 1930) have the imports of zirconium ores exceeded the 1934 quantity; and for the first time, at least since separate statistics have been available, the imports of zirconium alloys reached significant proportions.

Zirconium ores and alloys imported for consumption in the United States, 1930–34

Year	Zirconium ores		Ferrozirconium, zirconium, and zirconium ferrosilicon	
	Pounds	Value	Pounds	Value
1930	3,038,599	$40,416	1,215	$661
1931	1,124,034	18,945	496	312
1932	26,506	437		
1933	568,581	5,306		
1934	1,706,192	27,197	112,000	7,605

[45] Kinzie, C. J., and Commons, C. H. (Titanium Alloy Mfg. Co.), Zirconium Opacity in Enamels, Glazes, and Glasses: Jour. Am. Ceramic Soc., vol. 17, no. 10, October 1934, pp. 283–287.

ORE CONCENTRATION [1]

By T. H. Miller

SUMMARY OUTLINE

The total quantity of ore and old tailings treated at milling plants increased at least 8,900,000 tons in 1934 compared with 1933, according to preliminary figures. Copper ore of milling grade increased more than 3,000,000 tons due chiefly to gains in Arizona and Utah; zinc ore and old tailings increased about 2,680,000 tons and lead-zinc ore about 1,700,000 tons due chiefly to resumption of operations at many plants in the Tri-State region; and there were also substantial increases in gold and silver ore, copper-iron ore, and lead ore. Final data for 1933 are given in the following table; comparable totals for 1934 will be considerably larger.

Total nonferrous ore produced in the United States in 1933, by classes of ore and methods of treatment, in dry tons

Method of treatment	Copper ore	Copper-lead ore	Lead ore	Lead-zinc ore	Zinc ore	Gold and silver ore	Total ore
Straight flotation concentration	7,006,906	121,769	34,167	1,287,198	290,963	868,451	9,609,454
Combined gravity and flotation concentration	816,364		3,079,723	3,156,120	2,427,806	199,499	9,679,512
Straight gravity concentration			11,206	99,200	77,401	1,485	189,292
Total ore concentrated	7,823,270	121,769	3,125,096	4,542,518	2,796,170	1,069,435	19,478,258
Direct smelting	872,053	4,438	92,769	16,387	910	239,701	1,226,258
Amalgamation or cyanidation						3,200,240	3,200,240
Miscellaneous methods	37,421			232,400	538,117		807,938
Total ore, all methods:							
1933	8,732,744	126,207	3,217,865	4,791,305	3,335,197	4,509,376	24,712,694
1932	12,312,216	167,106	4,453,868	3,337,364	1,893,513	4,157,612	26,321,679

Total consumption of reagents was considerably greater in 1934 than in 1933 due to the large increase in quantity of material treated at flotation plants. In general, trends in flotation-reagent consumption were the same as in previous years. Reagent changes were made at two large copper concentrators, resulting in changes in consumption of synthetic collecting reagents. Flotation reagents used in treating gold and silver ores continued to expand as several new reagents or combinations were reported. Important changes also were reported at mills treating base ores, particularly at lead-zinc plants. The following table gives final flotation-reagent consumption data for 1933.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

Consumption of reagents in the treatment of all ores in 1933

[142 plants treating 12,968,228 tons of ore]

Reagent	Plants using	Ore treated (tons)	Consumption of reagents (pounds)		
			Total, 1933	Per ton	
				1933	1932
I. Frothers:					
Pine oils	110	7,647,672	745,954	0.098	0.105
Cresylic acid	61	7,430,534	1,023,568	.138	.165
Total frothers	142	12,968,228	1,769,522	.136	.147
II. Collectors:					
Distillation products:					
Coal-tar creosotes	29	3,891,938	641,937	.165	.190
Wood-tar creosotes	4	346,401	23,613	.068	.036
Petroleum products	3	8,271	1,968	.238	.001
Blast-furnace oils	2	603,490	91,463	.152	.122
Water-gas tars	1	15,195	960	.063	----------
Total distillation products	36	4,171,488	759,941	.182	.117
Synthetic products:					
Ethyl xanthates	88	5,648,288	597,305	.106	.085
Butyl xanthates	10	1,791,615	156,415	.087	.086
Amyl xanthates	45	1,206,691	118,422	.098	.035
Xanthate derivatives	3	312,446	31,345	.100	.011
Dicresol-dithiophosphoric acid	43	3,039,512	157,318	.052	.043
Sodium dicresol-dithiophosphate	25	3,534,003	124,382	.035	.044
Sodium diethyl-dithiophosphate	1	1,873,510	26,604	.014	.013
Thiocarbanilide	1	58,540	2,600	.044	.091
Total synthetic products	140	12,826,476	1,214,391	.095	.085
Total collectors	142	12,968,228	1,974,332	.152	.115
III. Acids and alkalies:					
Acids: Sulphuric acid	3	232,279	2,168,650	9.336	.072
Alkalies:					
Sodium carbonate	31	1,312,145	500,450	.381	.559
Sodium hydroxide	3	132,780	81,170	.611	.391
Lime	37	9,095,441	35,177,434	3.868	3.512
Total alkalies	61	9,649,778	35,759,054	3.706	3.462
IV. Other inorganic reagents:					
Sulphidizing: Sodium sulphide	14	541,544	309,178	.571	.187
Activating: Copper sulphate	57	3,259,596	2,892,878	.887	.674
Depressing:					
Cyanides	23	6,634,574	388,294	.059	.033
Sodium sulphite	5	367,369	289,770	.789	1.092
Sodium silicate	6	616,535	192,806	.313	.310
Zinc sulphate	21	2,598,046	983,505	.379	.374
Sodium bichromate	2	248,540	9,990	.040	.206
Total depressing	35	7,228,719	1,864,365	.258	.217
Miscellaneous [1]	4	200,506	151,989	.758	.900
Total reagents	142	12,968,228	46,889,968	3.616	3.399

[1] Includes zinc chloride, calcium sulphate, starch, chlorine, and lead acetate.

Little new construction or remodeling was reported at plants treating base-metal ores in 1934; the increase in material treated represented merely the reopening of existing plants rather than the construction of new ones. Several changes in flotation-reagent combinations were reported, and metallurgical results were improved. Most of the milling activity was accounted for at plants treating gold and silver ores. Many new plants were constructed and old plants were rebuilt, and although most of the plants were of rather small capacity a substantial increase in available gold- and silver-mill capacity resulted. Some of the new and rebuilt plants were of the straight flotation type and a few were straight amalgamation or cyanidation mills, but most of them were combination plants employing several methods of gold recovery.

The recent trend toward adoption of special equipment to recover gold in the primary grinding circuit was continued in 1934. A considerable number of gold and silver mills, both large and small, now employ traps, riffles, blankets, unit flotation cells, tables, and other equipment in the ball mill-classifier circuit to recover gold at as early a stage as possible. The use of corduroy or canvas tables is gaining favor. At a few plants that formerly used plate amalgamation the plates have been discontinued for other methods (given above) of recovering rich gold concentrates which are, in certain instances, treated in pan or barrel amalgamators to recover bullion. This new trend eventually may lead to a large decrease in the quantity of gold ore treated by direct amalgamation. Cyanidation continues to play an important part in gold-mill circuits either by direct application to the crude ore or flotation tailings or by treatment of gold concentrates.

Recovery of gold in the grinding circuit, together with better flotation results, has resulted in lower-grade tailings; however, in many cases, due to the increased price of gold the tailings still are too valuable to discard and cyanidation of final mill tailings to reduce tailings losses further is rapidly expanding.

There was an increase in both the number of gold and silver mills using flotation and the quantity of material treated. Most of the plants were combination mills using flotation in conjunction with other methods. As in the past, flotation-reagent combinations used in gold circuits continue to represent a large variety of types, and several new combinations were reported.

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PART III. NONMETALS

COAL [1]

By F. M. Shore, F. G. Tryon, and L. Mann

SUMMARY OUTLINE

Definite improvement characterized the operation of the coal industry as a whole in 1934, continuing the general upward trend of the industry's activities in 1933. Volume of output and consumption made encouraging upturns, employment and earnings of workers were higher, prices and realization of bituminous coal increased, and total exports gained materially in 1934. The percentages of the total product on handled mechanically in the mines and cleaned mechanically increased over the previous year. A further encouraging feature of developments in the coal industry in 1934 was a moderate improvement in the relative position of coal in the total supply of energy made available to the country. Of the total energy on a heat-value basis contributed by the several mineral fuels and water power in 1934, coal supplied 54 percent compared with 52.2 percent in 1933, halting a downward trend of this factor that had persisted since 1926. In the bituminous-coal industry maximum hours of labor were reduced, minimum rates of pay were increased, prices advanced, and operators as a whole improved their financial position. Anthracite prices changed little from the previous year.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

The increased demand responsible for the larger output of coal in 1934 can be attributed chiefly to the improvement in general industrial activity which marked the year as a whole and which, though moderate in amount, was more stable than in 1933. The Federal Reserve Board index of industrial production showed a gain of 3 points (about 4 percent) over the previous year and monthly fluctuations within a much narrower range than characterized the disturbed conditions of 1933. According to the same authority total manufactures increased by about the same percentage, but many of the large users of coal made much greater gains than the manufacturing industry as a whole. In general, the rate of coal production followed normal seasonal trends except for a stimulated output of bituminous coal in March due largely to consumer requirements for increased stocks in anticipation of possible suspension of production upon the expiration of existing wage agreements at the end of the quarter.

The increased industrial demand for coal in 1934 was supplemented by larger requirements for heating, induced by lower average temperatures in the heavy consuming areas of the country and in part, it is believed, by an increase of purchasing power.

The bituminous-coal industry operated throughout the year under the provisions of the code of fair competition that became effective October 2, 1933. The coal-distributing agencies—wholesale, retail, and coal docks—were organized under codes early in the year and continued to operate thereunder for the remainder of the year. Negotiations to effect a code for the Pennsylvania anthracite industry were unsuccessful, and the industry operated without a code.

Due to the great number and wide distribution of the units comprising the coal industry of the country considerable time is required to obtain reports from all of the mines. As this book goes to press many mines have not yet reported their operations for 1934. The following analysis is based chiefly on preliminary figures, which are subject to revision; detailed figures will be published later.

Salient statistics of the coal industry, 1933–34 [1]

[All tonnage figures represent net tons of 2,000 pounds]

	Bituminous coal			Pennsylvania anthracite		
	1933	1934 [1]	Percent of change in 1934	1933	1934 [1]	Percent of change in 1934
Production.....net tons..	333,630,533	358,395,000	+7.4	49,541,344	57,385,000	+15.8
Value at mines..........	$445,788,000	$652,279,000	+46.3	$206,718,000	$243,312,000	+17.7
Average value per ton....	$1.34	$1.82	+35.8	$4.17	$4.24	+1.7
Average retail price [2].....	$7.65	$8.26	+8.0	$13.18	[3] $13.12	−0.5
Stocks on hand: [4]						
Jan. 1......net tons..	29,666,000	32,840,000	+10.7	1,732,216	1,106,085	−36.1
Dec. 31.........do....	32,840,000	34,476,000	+5.0	1,106,085	1,920,833	+73.7
Exports............do....	9,036,947	10,868,552	+20.3	1,034,563	1,297,611	+25.4
Imports............do....	197,269	179,661	−8.9	456,252	478,118	+4.8
Consumption (calculated).........net tons..	321,748,000	346,070,000	+7.6	49,589,000	55,751,000	+12.4
Number of men employed................	418,703	450,000	+7.5	104,633	[5] 106,251	+1.5

[1] Figures for 1934 are in most instances preliminary and subject to revision.
[2] Compiled by Bureau of Labor Statistics, U. S. Department of Labor.
[3] Represents average retail price of stove coal only.
[4] Figures for bituminous coal represent consumers' stocks; for anthracite, producers' stocks.
[5] Pennsylvania Department of Mines.

BITUMINOUS COAL

BITUMINOUS-COAL CODE

The account of developments in the bituminous-coal industry during 1934 will record for the first time the results of a full calendar year of operation under a code providing for uniform trade practices, maximum hours of labor, minimum standard wages in each producing district, and minimum prices established by industry subject to approval by the Government.

At the time of writing complete data are not available for a yearly period immediately before or after adoption of the code, so that the full effects resulting from its provisions cannot be measured adequately compared with the record of preceding years. However, some light is thrown on the subject by preliminary and sample data already at hand. It will aid the interpretation of these data to outline briefly the organization set up by the code for the bituminous industry and the modifications in code provisions that were effected during 1934.

For purposes of administration the bituminous-coal-producing industry was organized in five divisions, separated further into subdivisions in most instances, the administrative functions of each unit being lodged in a code authority composed of representatives of the industry and a representative of the Government appointed by the President. The areas covered are as follows:

Division I, representing about 71.5 percent of the 10-year average precode production of the country, covers the coal-producing territory east of the Mississippi, excepting Indiana, Illinois, Alabama, Georgia, and southern Tennessee. It embraces therefore the great bulk of the Appalachian fields—Pennsylvania, Ohio, West Virginia, Maryland, Virginia, eastern Kentucky, and northern Tennessee, together with the outlying districts of North Carolina, Michigan, and western Kentucky.

Division II, representing about 16.3 percent of the annual average tonnage, comprises the States of Indiana, Illinois, and Iowa.

Division III, representing about 3.7 percent of the annual average tonnage, includes the coal-producing areas in Alabama, Georgia, and southern Tennessee.

Division IV, with about 2.5 percent of the annual average production, includes the Southwestern States of Missouri, Kansas, Arkansas, Oklahoma, and Texas.

Division V, representing about 6 percent of the total annual production, includes the Rocky Mountain and Pacific States and the Dakotas.

A Bituminous Coal Industrial Board was established to consider and make recommendations as to any amendments of this code or other measures for stabilization and improvement of conditions in the industry. The Board consisted of representatives of divisional code authorities, the Presidential members of such authorities, and not more than three other members to be appointed by the President.

Labor grievances and interpretation of wage agreements under the code were the province of bituminous coal labor boards set up in each division, subject to appeal to the National Bituminous Coal Labor Board. To establish standard wage rates the producing areas were grouped into 17 wage districts, corresponding closely to producing fields commonly recognized in trade and labor relations of the industry.

In common with all codes of fair competition provision also was made for the prevention of child labor in the industry.

Hours of labor.—The original code established throughout all producing fields the maximum working week of 40 hours composed of 5 days of 8 hours each, a reduction from the longer week—usually

48 hours (6 days)—which had prevailed previously. By amendment 1, effective April 1, 1934, the maximum working time was reduced to a 35-hour week consisting of 5 days of 7 hours each.

Wage rates.—Basic minimum daily and hourly rates were established by the code for outside common labor and inside skilled labor in each of the 17 wage districts set up, with the understanding that rates for other day workers and for tonnage workers would be fixed by joint agreement, so as to maintain customary relationships to the basic day rates. For some districts already operating under union wage agreements no change in minimum basic rates was provided originally in the code. As the greater part of the industry was not operating under wage agreements the rates established originally for most of the production represented substantial increases over those that prevailed formerly. Basic minimum rates as originally established by the code fixed a differential of 40 cents per day between the northern and southern fields of division I that remained unchanged. By amendment 1, effective April 1, 1934, basic minimum day and hour rates were increased in most districts. In districts where no change was made in the basic day rates, hourly rates were raised to compensate for the shorter day established. The minimum day rate for inside labor was increased by amendment 1 from $4.60 to $5 in the northern fields of division I and from $4.20 to $4.60 in the southern fields. In the intermediate field of northern West Virginia the rate was increased from $4.36 to $5, in the southwestern fields from $3.75 to $4.60, and in Alabama and Georgia from $3.40 to $4.60. The rate in western Kentucky was raised from $4 to $4.60, in New Mexico from $4.48 to $5.10, in southern Colorado from $4.44 to $5.10, northern Colorado from $5 to $5.25, and in the Dakotas from $4 to $4.50. Strong protests were made against the increased rates in a number of districts, and by amendment 2, approved April 22 and retroactive to April 1, the rates were reduced on the basis of the inside skilled labor rate in the following districts: Southwest (Missouri, Kansas, Arkansas, and Oklahoma), to $4.35; Alabama, Georgia, and Hamilton and Rhea Counties of southern Tennessee, to $3.80; and in other counties of southern Tennessee, from $4.60 to $4.24. Western Kentucky refused to accept the rates established for that district by amendment 1, obtained an injunction in the Federal courts to prevent their enforcement, and is said to have continued to pay wages on the basis of $4 for inside day labor (Coal Age, February 1935, p. 84). By amendment 3, effective June 11, the rate for the deep mines of the Southwest was reduced further to $4, but for strip mines it remained at $4.35. The reduction granted division III by amendment 2 and that allowed in division IV by amendment 3 were accompanied by the stipulation that no sales could be made in the normal consuming markets of another district paying higher wage scales at prices less than those charged by such other district.

Statistics.—With the adoption of the code a comprehensive system for gathering statistical data from the industry was inaugurated by the National Recovery Administration and placed under the Bituminous Coal Code Section of the Research and Planning Division. For November and December 1933 and January 1934 voluminous data were compiled on the cost of production, employment and earnings, and realization. The collection of data on employment, earnings, and detailed realization ended in January 1934; the only reporting that continued after April was that covering the cost of production, and this was on a purely voluntary basis. On that basis most of the fields in divisions I, II, and III have reported costs throughout 1934.

By the provisions of amendment 2 to the code, approved April 22, 1934, a bituminous-coal research unit was to be established in the Research and Planning Division named, and charged with the duty of conducting a study as to adjustments in the price situation equitably required in consideration of the rates of pay in the several districts, to advise the Administrator of the N. R. A. on approval of proposed prices, and to make recommendations concerning readjustment of the price structure. Inability of the representatives of the several fields to agree as to basic definitions and conditions of reporting has prevented satisfactory consummation of the above program.

By amendment 4, approved November 5, 1934, provision was made for the establishment by each code authority of a local statistical bureau, to which producers were required to report all spot orders and with which they were to file copies of all contracts for the sale of coal, copies of all invoices and credit memoranda, and such other information concerning the sale of coal as the code authority, with the approval of its Presidential member, might require. While some progress was made in the organization of these statistical bureaus under the amendment, relatively few had been established by the end of the year.

Prices.—The code provided that coal could not be sold at less than fair market prices, which were the minimum prices for the various grades and sizes in the consuming markets established, with the approval of representatives of the Government, by marketing agencies acting for the producers of at least two thirds of the commercial tonnage of any district or group of districts. From the beginning of operations under the code the problem of maintaining an equitable equilibrium of prices in and among competing districts proved difficult to solve, and controversies over the correlation of prices continued to disturb the situation in many of the producing fields. In June a movement was initiated by the National Recovery Administration to establish by agreement a uniform procedure for advance submission of schedules involving proposed price changes to the Deputy Administrator of the N. R. A., to each Presidential member of the various code authorities, and to each subdivision affected by the proposed changes in prices, thus affording opportunity for the consideration of any protest that might be filed in opposition to the changes proposed. A meeting of all Presidential members and the chairman of code authorities and marketing agencies was provided by the plan, to be held in Washington at least 5 days before the effective date of any price changes, to permit the review provided for by the code.

Correlation of prices in relation to production.—In July a plan was designed for facilitating the correlation of prices between all the subdivisions of division I, except Michigan and west Kentucky. The plan, briefly, was to ascertain the production record for a series of years in each subdivision and to calculate the proportion that each subdivision's total was of the grand total for division I, then to collect current monthly data on production in each subdivision and ascertain the relationship of current monthly production to past annual production. The share obtained each month by each subdivision was to be one of the major factors considered in correlating prices between subdivisions. Each subdivision was assigned a percentage of the total tonnage for the division, based primarily on its production record over the 5 years, 1929–33, after captive tonnage was excluded, and was required to file with the N. R. A. before the 25th of each month a statement showing its production during the preceding month, to be checked against Bureau of Mines figures. Production varying greatly from the percentages assigned to the subdivisions was to be used as a signal for revision of prices to adjust output to established relationships.

This plan, known as the "Adams agreement", was in effect for 6 months and was considered a step forward. Objections arose, however, both to the method and to the percentages used, especially from certain of the districts, and upon its expiration the agreement was not renewed. At the close of 1934 other methods of price correlation were being developed, and the problem of evasions and compliance was coming to the fore. Discussion of these developments, however, belongs to the record of 1935.

"Virginia anthracite."—Under the original code organization the semianthracite mines in Montgomery and Pulaski Counties, Va., were officially considered a part of southern subdivision 1 of division I and reported their production to the code authority of that subdivision. By a ruling of the National Recovery Administration in September 1934 it was held that these operations did not come under the provisions of the Bituminous Coal Code.

Progress under the code.—The exact measure of the influence of code provisions upon the various basic factors of operations in the bituminous-coal industry in 1934 cannot be stated owing to lack of complete data. Labor obtained the important advantages of a shorter day and week, together with increased wage rates in many districts. In fact, upon adoption of the 7-hour day, hourly rates advanced in all districts. According to information compiled by the Bureau of Labor Statistics covering a large sample of the industry the index of employment at bituminous-coal mines in 1934 was 77.2 (basis, 1929 average=100), compared with 67.9 in 1933—an increase of 13.7 percent. On the same basis the index of pay rolls increased from 37.8 in 1933 to 54.2 in 1934, or 43 percent. The larger percentage increase in pay rolls would indicate higher earnings per man.

From such information as is now available it seems apparent that the operators obtained better prices for the major part of their output in 1934 than in 1933 and likewise a higher gross realization per ton. The benefits of the higher level of minimum prices established under the code were offset somewhat by the substantial tonnage shipped during the year on precode contracts at lower price levels and to a large degree by increased labor costs and other costs of production.

The cost data supplied to the Research and Planning Division of N. R. A. show the following results for the calendar year 1934:

All mines reporting from—	Average sales realization	Average cost [1]
Division I [2]	$1.833	$1.814
Division II [3]	1.585	1.489
Division III	2.150	2.167
Total, divisions I to III	1.800	1.769

[1] Including depreciation and depletion; excluding interest on borrowed money and Federal income taxes.
[2] Not including west Kentucky.
[3] Not including Iowa.

These data suggest the possibility of a small margin of profit for the industry as a whole in 1934. When this showing is compared with the huge losses in the earlier years of the depression, as indicated by the companies reporting under the Federal income tax ($47,745,000 in 1931 and $51,157,000 in 1932)[2], it seems clear that the code effected a marked improvement in the financial position of the industry.

Quantitative appraisal of the results of the code will have to await publication of final data. Meanwhile, the following quotation from a report of the National Resources Board is of interest:

> Despite numerous criticisms, the code has achieved a great measure of success. Criticisms of delay on the one hand and of overhasty action on the other are natural in so new and so large an undertaking. Complaints of discrimination are heard from individual producers. Correlating price differentials between competing districts has proved difficult. Evasions threaten to reach grave proportions unless the power to force compliance is upheld by the courts. Yet in comparison with the competitive chaos which preceded it, the code is a great achievement. For the first time in years prices have generally been held above production costs. Employers, now able to pay the agreed-on wage, have taken a different view of labor relations. Wage standards and working conditions in the East and South are better than for years past. This has been accomplished without unreasonable burdening of the consumer or serious curtailment of demand. Opinion in so large an industry is always divided, yet it is generally agreed that many features of the code should be continued. It is clear, therefore, that nothing should be done to handicap administration of the present code and that the experience gained under the code should guide any future attempt to adjust supply and demand in this industry.[3]

THE MARKET IN 1934

Production.—The bituminous-coal market improved definitely in 1934. Production, consumption, prices, employment, and pay-roll totals all advanced materially over 1933. In volume of output the industry achieved a larger percentage of gain than was made by the mineral industry as a whole or by the total industrial production as recorded by the index numbers of the Federal Reserve Board. In addition to increased industrial consumption, lower average temperatures in many of the more densely populated States indicate an increase in the quantity of coal used for domestic heating. Shorter working hours, stabilized wage rates (at higher levels in many fields), and higher and steadier prices under the code all had an important effect upon the market.

[2] Bureau of Internal Revenue, Statistics of Income. The figures are as reported by the taxpayer, and the losses may have been reduced by the subsequent audit. Nevertheless, it is clear that prior to the code the industry was operating at a heavy loss.
[3] National Resources Board, Report of the Planning Committee for Mineral Policy: Pt. IV, Dec. 1, 1934, pp. 402, 403.

In 1934 the upward trend in the output of bituminous coal continued, with an increase over 1933 of 7.4 percent, practically the same rate of gain as in the previous year. The production in 1934 was 358,395,000 net tons and that in 1933, 333,631,000 tons—a gain of 24,764,000 tons. Compared with 1932, 48,685,000 more tons of coal were raised (a gain of 15.7 percent). Despite the increase the output for 1934 was far below that for many years before 1932.

Monthly output.—The normal demand of the winter months was stimulated by a material increase in general industrial activity which began in January, aided by almost unprecedented cold weather prevailing in many sections of the Eastern States in February and the first half of March. Output increased decisively in March due to the prospect of labor disturbances upon the expiration of the existing wage agreements at the end of the month and a consequent increase in stocks, largely by the railroads, cement mills, and byproduct ovens. The next 3 months were influenced largely by the usual seasonal decline, although production was sustained above the level of the pre-

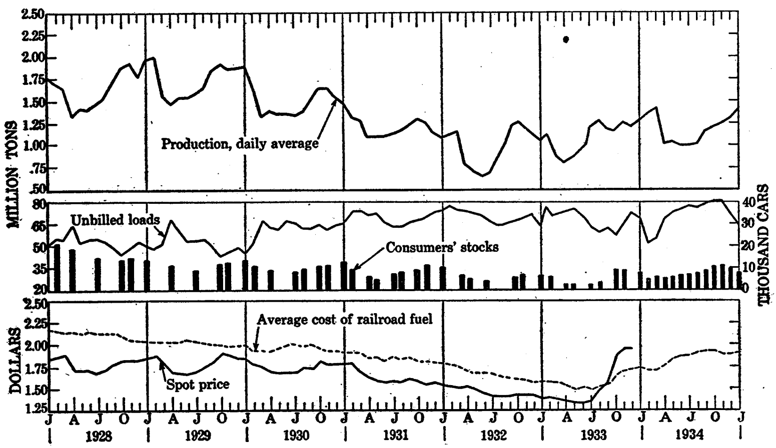

FIGURE 37.—Trends of production, stocks, and prices of bituminous coal, 1928–34.

vious year by a better rate of general industrial activity. Reflecting a decline in general business, consumption by all the major industrial groups was decidedly lower in July, and the production of bituminous coal was the lowest in the year, except in April when consumers were using the large stocks accumulated during March. Although industrial consumption continued to decline slightly in August coal production showed definite improvement, which was continued in September as cooler temperature increased the demand for household fuel. Industrial consumption improved decisively in October and continued to expand during the remainder of the year. Bituminous-coal production was accordingly at a much better rate than in the third quarter and was well above that in the corresponding period of 1933. Except for July, August, and September, when the production of bituminous coal in 1933 was influenced by the boom period of that year, the monthly production in 1934 was above that of the corresponding periods of the previous year.

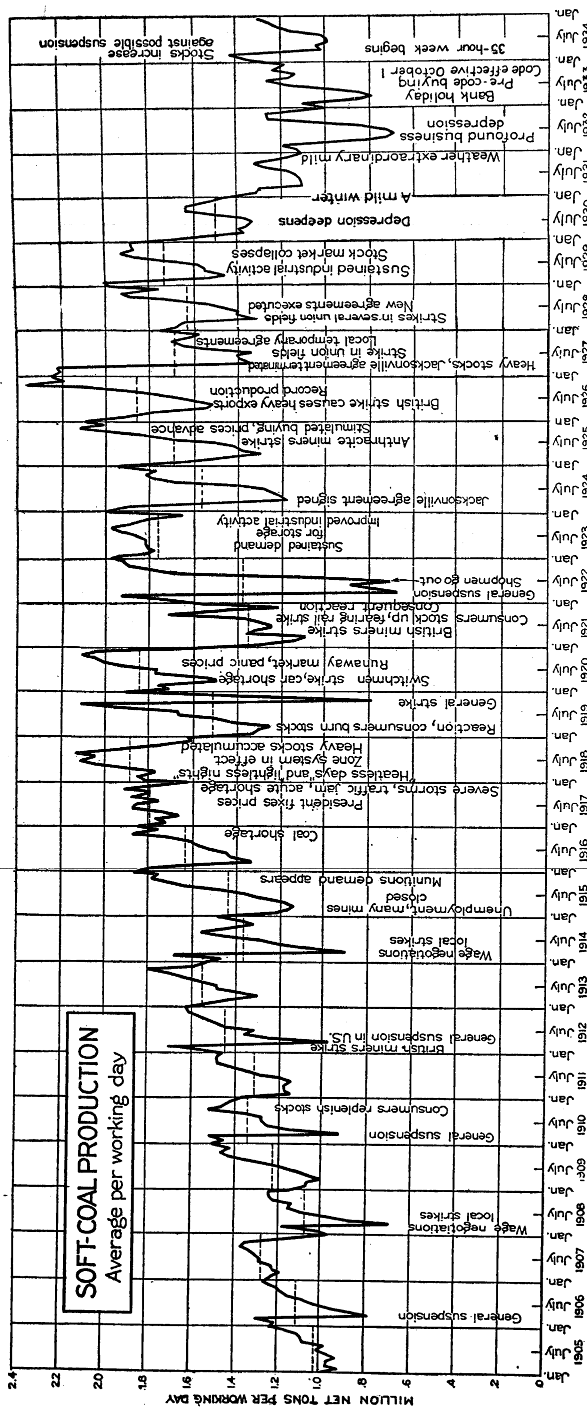

FIGURE 38.—Average production of bituminous coal per working day in each month, 1905–34.

Commercial stocks.—In the main, the trend of commercial stocks followed the usual seasonal fluctuations, and monthly totals were consistently higher than in 1933, except in September. The difference in that month was due to the fact that in August and September of 1933 the railroads in the East stocked up heavily, anticipating possible labor difficulties at the mines which did not materialize.

The reserves of coal in the bins of industrial consumers and retail dealers at the end of 1934 had risen from 32,840,000 tons, on hand January 1, to 34,476,000 tons, an increase of 1,636,000 tons (5 percent). This increase was almost entirely in the stock piles of retail dealers. These stocks climbed from 7,100,000 tons on January 1 to 9,100,000 on December 31—a difference of 2,000,000 tons (28 percent). Many groups of industrial consumers of coal reduced their stocks during the year.

Consumption.—Taking into consideration imports and exports and changes in stocks within the year consumption of bituminous coal rose from 321,748,000 to 346,070,000 tons, an increase of 24,322,000

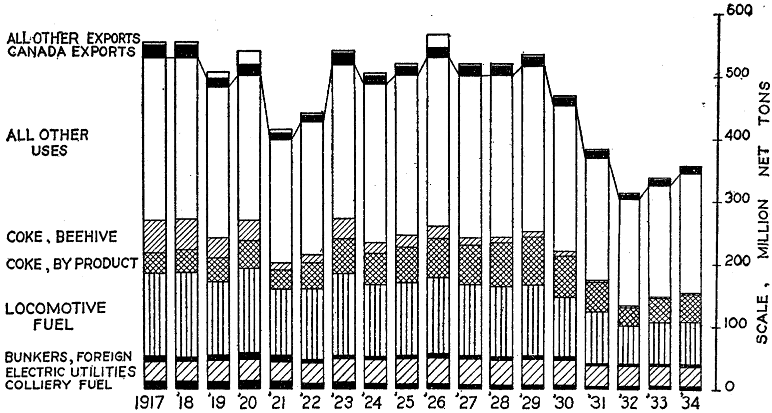

FIGURE 39.—Tonnage of bituminous coal absorbed by the principal branches of consumption, 1917–34.

tons. This was only 400,000 tons less than the increase in the total output and represented the same degree of growth—about 7 percent.

The greater demand was general in all industries, particularly at coke ovens and in cement mills. Increased activity in rail transportation, due largely to the increased tonnage supplied by bituminous coal, was reflected by a substantial gain in consumption of coal by locomotives of class I railroads. Consumption by central electric plants rose 9.1 percent over 1933. Consumption by byproduct and beehive coke ovens increased 16.2 percent and 13.6 percent, respectively, while greater activity in the steel industry is indicated by a larger use of bituminous coal, amounting to 8.9 percent. Coal-gas retorts also increased their coal consumption slightly, but the largest gain was recorded by the cement mills, where the consumption of coal in 1934 was 22.1 percent higher than in the preceding year.

Prices.—Continuing the rise in prices begun in 1933 a substantial increase was attained in 1934, following wage advances in many of the producing fields. The average cost of railroad fuel, excluding freight charges, as reported to the Interstate Commerce Commission, began the year at $1.73 per net ton and closed it at $1.89. This was a 9-percent increase within the year but a 16.9-percent gain if the respective averages for the 2 years as a whole are compared. After a drop to $1.71 in February—maintained in March—the monthly average price began a consistent advance, which carried it to $1.92 for September and October, and finished the year at $1.89.

Retail prices varied less in the monthly reports for 38 cities. In January the price was $8.24 per ton and in December $8.36, only 12 cents difference. However, the yearly average rose from $7.65 in 1933 to $8.26 in 1934, a net change of 61 cents (8 percent). Customary seasonal trends in demand are reflected in the decline of retail prices from January to May and in a consistent upward trend during the remaining months of the year.

The average sales realization on all coal produced in 1934 is estimated at $1.82 a ton. This is a preliminary figure based on incomplete returns from the operators and subject to revision when final data have been received. Compared with the 1933 figure of $1.34 this is an increase of 48 cents (35.8 percent).

Statistical summary of monthly developments in the bituminous-coal industry in 1934

[All tonnage figures represent thousands of net tons]

	1934													1933 total
	January	February	March	April	May	June	July	August	September	October	November	December	Total	
Production, including mine fuel and local sales:														
Monthly total	33,371	32,606	38,470	24,599	27,385	25,877	24,869	27,452	27,772	32,807	30,856	32,331	358,395	333,631
Average per working day	1,279	1,359	1,425	1,016	1,037	995	995	1,017	1,157	1,215	1,249	1,293	1,170	1,090
Distribution:														
Rail movement (including railway fuel):														
From Appalachians north of Alabama:														
To tidewater	2,596	2,350	2,970	2,345	2,347	2,286	2,089	2,053	2,144	2,483	2,428	2,652	28,743	27,126
To New England	594	527	699	410	403	333	320	359	374	459	495	537	5,510	4,824
To Lake Erie	83	120	399	2,201	4,840	5,375	5,163	5,080	4,253	4,135	2,654	93	[1] 34,396	29,767
West-bound commercial	7,046	7,975	9,200	4,625	3,942	3,600	3,278	3,780	4,302	4,796	5,364	6,571	[1] 64,479	57,948
East and south-bound, local and railway fuel (all rail)	8,939	9,027	11,132	6,411	7,406	6,150	6,231	6,617	5,947	8,116	7,540	7,742	[1] 91,258	88,300
From Alabama field	886	936	852	459	909	784	690	699	667	727	659	743	9,011	8,353
From interior fields	6,881	6,523	7,148	3,925	3,650	3,566	3,778	4,760	5,455	6,277	5,998	7,442	65,403	61,102
From far western fields	1,718	1,304	1,318	964	866	793	863	1,179	1,641	2,019	1,861	1,945	16,471	15,840
Lake dock receipts	7	9	10	32	1,874	2,324	2,144	1,883	1,600	1,511	1,118	45	12,557	11,068
Lake dock deliveries	1,340	1,207	1,110	945	654	657	575	711	955	1,023	1,026	1,331	11,534	11,390
New England tide receipts (preliminary)	1,201	1,037	1,202	1,083	1,000	851	747	704	785	1,004	1,004	966	11,584	11,197
Exports to Canada and Mexico	385	363	494	689	1,126	1,058	1,206	1,129	1,098	1,148	989	527	10,212	8,600
Exports to Caribbean region	19	29	46	50	51	18	28	18	49	25	29	47	409	222
Exports "overseas"	10	36	9	16	26	34	7	14	10	13	45	28	248	215
Imports	25	22	22	11	7	7	6	10	8	21	20	21	180	197
Industrial consumption by:														
Railroads (class I only)	6,826	6,736	7,383	6,357	6,108	5,763	5,783	5,902	5,900	6,355	6,117	6,817	76,047	71,287
Electric-power utilities	2,665	2,735	2,668	2,267	2,514	2,639	2,752	2,822	2,606	2,761	2,559	2,722	31,710	29,078
Byproduct coke ovens	3,621	3,645	4,341	4,211	4,676	4,379	3,448	3,306	3,153	3,359	3,287	3,503	44,929	38,681
Beehive coke ovens	173	207	259	115	101	98	82	70	88	122	151	134	1,600	1,408
Steel works and rolling mills	986	1,088	1,209	1,043	1,120	1,060	698	654	608	717	775	942	10,900	10,009
Coal-gas retorts	216	208	220	212	216	196	191	197	198	207	201	212	2,474	2,398
Cement mills	163	184	249	292	374	410	371	347	341	305	250	180	3,466	2,838
Other industrials	7,801	8,204	8,253	7,135	6,500	5,900	5,640	5,960	5,685	6,910	7,520	8,290	83,798	78,045
Bunker coal, foreign	82	78	101	91	137	120	113	133	109	122	135	99	1,320	1,316
Coal-mine fuel	286	279	330	211	235	222	213	235	238	281	264	277	3,071	2,858
Stocks at end of period shown:														
Railroads (class I only)	4,680	4,260	5,606	4,819	4,518	4,681	5,100	4,895	4,951	4,916	5,025	4,862	4,862	5,016
Electric-power utilities	5,251	5,001	5,194	5,257	5,192	5,209	5,077	5,162	5,468	5,631	5,624	5,507	5,507	5,320
Byproduct coke ovens	5,681	4,796	5,064	4,627	4,795	5,288	5,563	5,784	5,715	5,924	6,139	5,577	5,577	6,061
Steel works and rolling mills	1,060	967	962	890	915	935	969	927	887	847	824	817	817	1,025
Coal-gas retorts	452	394	401	394	419	428	464	472	480	514	516	482	482	482

Cement mills	254	248	278	267	301	312	281	261	252	250	229	232	232	249
Other industrials	7, 245	6, 324	6, 456	6, 657	6, 850	6, 740	6, 640	6, 940	7, 477	7, 728	8, 099	7, 905	7, 905	7, 585
Total commercial stocks	31, 023	27, 100	28, 371	27, 711	28, 490	29, 493	30, 387	31, 441	33, 077	35, 810	36, 356	34, 476	34, 476	32, 840
Stocks on Lake docks	5, 258	4, 143	3, 068	2, 144	3, 363	4, 998	6, 582	7, 795	8, 441	8, 929	9, 024	7, 738	7, 738	6, 590
Unbilled loads	1, 630	1, 053	1, 151	1, 623	1, 764	1, 816	1, 912	1, 855	1, 973	2, 052	2, 087	1, 736	1, 736	1, 533
Trend of prices (average per net ton):														
Average cost of railroad fuel, excluding freight charges	$1. 73	$1. 71	$1. 71	$1. 76	$1. 83	$1. 87	$1. 88	$1. 91	$1. 92	$1. 92	$1. 89	$1. 89	$1. 84	$1. 57
Average retail price, 38 cities	$8. 24	$8. 22	$8. 23	$8. 18	$8. 13	$8. 18	$8. 23	$8. 30	$8. 31	$8. 35	$8. 35	$8. 36	$8. 26	$7. 65
Index of wholesale prices (1926=100.0)[2]	90. 8	91. 1	91. 1	93. 7	94. 6	95. 0	95. 7	96. 2	96. 3	96. 4	96. 4	96. 5	94. 5	82. 8
Labor conditions:[2]														
Index of employment (1929 average=100.0)	75. 8	76. 1	77. 8	72. 2	76. 7	76. 7	77. 0	77. 1	78. 2	79. 3	79. 8	79. 7	77. 2	67. 9
Index of pay-roll totals (1929 average=100.0)	51. 3	54. 6	58. 9	51. 4	54. 4	55. 1	49. 7	50. 4	51. 4	57. 6	58. 3	57. 0	54. 2	37. 8

[1] Because of certain additions to the origin groups reported by the railroads under shipments "To Lake Erie" and to the destination groups included in "West-bound commercial" which became effective Jan. 1, the 1934 figures for these three items are not exactly comparable with those for earlier years. On a basis strictly comparable with 1933, the totals for 1934 are as follows: "To Lake Erie"—33,203,000 tons; "West-bound commercial"—63,366,000 tons; "East and south-bound, local and railway fuel"—93,564,000 tons.

[2] Bureau of Labor Statistics index numbers.

Employment and earnings.—In line with the continued improvement in market conditions and the shorter working hours that prevailed most of the year, more men were at work in bituminous-coal mines in 1934. A preliminary figure of employment, as indicated by incomplete returns from the operators to the Bureau of Mines, is about 450,000, which compared with the more accurate data for 1933 represents an increase of some 31,000 men (about 7.6 percent). This was larger than for any year since 1930, when the records show 493,202 employees in the industry.

The best guide to current fluctuation in employment at the mines is the monthly report of the Bureau of Labor Statistics, covering about 1,400 mines and probably more than half the workers in the industry. With the average for 1929 as 100 the index of the number of men on the pay rolls of the mines canvassed was 75.8 in January 1934 and did not fall below that figure, or even touch that as a low, throughout the year except in April, when 72.2 was registered. In November the high mark of the year was reached, 79.8; the index dropped slightly to 79.7 in December. For the year as a whole the index of employees on the rolls averaged 77.2 compared with 67.9 in 1933, a gain of nearly 14 percent.

The total wages paid these men showed a much larger advance. With 1929 as 100 the wage index for the year indicated a 43-percent rise—from 37.8 to 54.2.

Except during the period following the establishment on April 1 by amendment 1 to the Bituminous-Coal Code of a shorter working day and week for the industry in general and advances in wage rates for many of the producing fields, there were no serious suspensions of mining in 1934. In some fields the operators protested the increased wage rates, and operations were suspended at many mines while negotiations for modification of rates were pending. It is reported that certain Iowa mines and the shaft mines of the Southwest were closed in April as a result of disagreement over the wage increases prescribed by the code amendment of April 1. Continued idleness in the shaft mines of the Southwest was reported for May due to further dissatisfaction of operators with the reduced scale granted by the code amendment of April 22. A more serious suspension, however, occurred in division III, embracing Alabama, Georgia, and southern Tennessee. In Alabama virtually all commercial mines were reported closed April 6, and a temporary injunction was obtained restraining enforcement of the order establishing a basic day rate of $4.60 for a 7-hour day. Attempts to resume operations at a lower scale were unsuccessful and production was largely at a standstill until a new agreement with the workers was effected under the reduction of the basic rate to $3.80 granted by the code amendment of April 22.

With a few exceptions the operators of northern West Virginia declined to accept the provisions of code amendment 1, raising the basic day rate in that field to the level of that for the northern fields and eliminating the differential that had prevailed previously in favor of the former. As a result, most of the mines were reported closed from April 1 to April 22, when code amendment 2 granted the field some concessions in loading and cutting rates, leaving the basic inside day rate at $5 as established by the first amendment.

Distribution trends.—The flow of coal from the producing fields to the consuming regions is grouped into its major movements for purposes of convenient comparison in figure 40, which shows the monthly variations in bituminous tonnages moving in each group during 1933 and 1934.

The Nation-wide scope of the increased demand for bituminous coal in 1934 is shown by the curves of figure 40 which indicate annual gains in each of the major channels of distribution. Of particular note is the increase of 11.5 percent in shipments to Lake Erie loading ports, following a gain of 25.7 percent in 1933. The shipments from the mines to lower Lake Erie ports for loading into vessels reached a total of 34,396,000 tons in 1934. This total, however, includes coal from certain origin groups not covered by the record before January 1934. On a basis strictly comparable with earlier years the record for the year is 33,203,000 tons as against 29,767,000 tons in 1933.[4] With the opening of the Lake season shipments from the producing fields began in a volume much heavier than that of the previous year, and monthly shipments continued to outstrip those of 1933 through

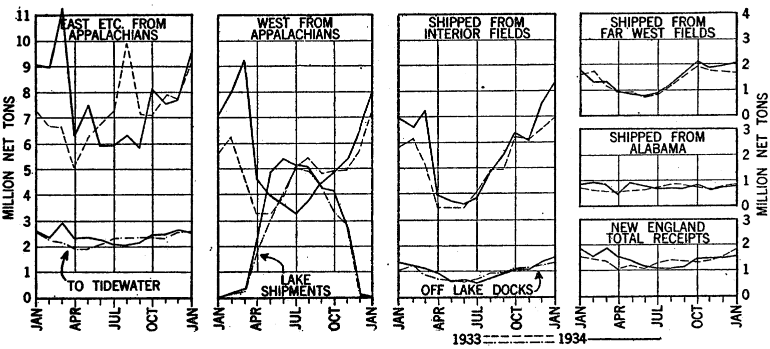

FIGURE 40.—Monthly movement of bituminous coal in the major channels of distribution, 1933–34.

August, when they had reached a total about 22 percent greater than for the same period of 1933. Shipments to the Lakes during the balance of the year were but slightly above those for the corresponding periods of 1933, in line with the lower rate of general industrial production which began in July.

West-bound commercial shipments from the Appalachian fields north of Alabama increased 9.3 percent over those of the previous year. This movement was particularly heavy in the first quarter of the year, which accounted for 37 percent of the annual volume. Thereafter, the west-bound shipments dropped to 19 percent of the annual total in the second quarter and 18 percent in the third quarter, the decline reflecting the seasonal character of this movement. The fourth quarter brought a revival of the movement and accounted for 26 percent of the year's total.

East- and south-bound shipments from the Appalachian fields made a modest gain of 6.0 percent over 1933. As in the west-bound movement, the heaviest volume occurred during the first quarter of

[4] The total dumped at Lake Erie ports from all fields, including vessel fuel which has been recorded for many years, was 32,333,000 tons in 1933 and 35,971,000 tons in 1934.

the year, which accounted for about 32 percent of the annual total. The second and third quarter shipments were considerably less, followed by an increase in the final quarter of the year which accounted for approximately 25 percent of the annual total.

The New England trade recorded a substantial increase amounting to 14.2 percent over the previous year; total shipments to tidewater gained 6 percent; and those from the Alabama field and the interior fields increased about 8 percent and 7 percent, respectively. A more modest increase of 4 percent was recorded by the shipments from far-western fields. Deliveries from the upper Lake docks improved by slightly more than 1 percent, much of the increase in shipments up the Lakes going into storage.

Exports.—The quantity of bituminous coal exported increased substantially from a total of 9,036,947 net tons in 1933 to 10,868,552 tons

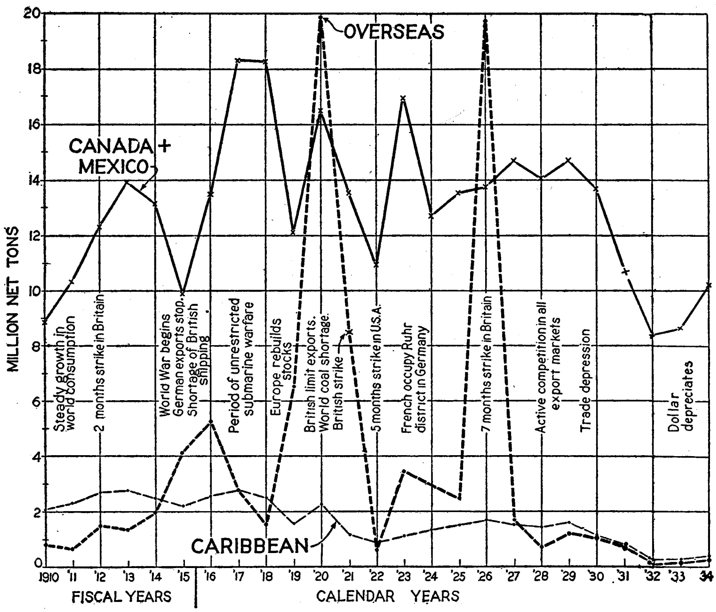

FIGURE 41.—Twenty-five years' exports of bituminous coal to (1) Canada and Mexico, (2) the Caribbean and (3) "overseas" destinations.

in 1934, a gain of 1,831,605 tons (20.3 percent) and the largest volume since 1931. The partial recovery of exports was facilitated by depreciation of the dollar in foreign exchange.

While many countries in the Americas use bituminous coal from this country, the principal customer for this product is Canada, which usually takes over 90 percent of the total exports. (See fig. 41.) In 1934 exports of bituminous coal to Canada were 10,210,069 net tons—an increase of 18.7 percent over 1933 and 93.9 percent of the total exports. According to figures of the Dominion Bureau of Statistics of Canada, imports of bituminous coal from the United States in 1934 comprised 97 percent of Canada's total bituminous-coal imports compared with 96 percent in 1933. Although Canada has ample resources of coal, they are located in the coastal regions, the Rockies, and the western plains, and the cost of transportation to the populous industrial regions of the Central Provinces has militated against a larger use of the domestic supply. The high quality and economic availability of coals from this country have, accordingly, favored their use in the heavy consuming areas of the Canadian market. Normally Canada imports about one half of its total requirements of coal of all grades. In recent years, the Canadian Government has tried to stimulate the use of domestic coals through subventions to transportation cost, subsidies on Canadian coal sold for ship's stores or export, increased tariff, antidumping duty, and requiring the use of Canadian coals in connection with imported coals in coke plants to entitle their operators to the drawback on duties paid on the latter.

Other than shipments to Canada, United States exports of bituminous coal have not been important, except in years when the normal flow of coal in international trade has been disturbed by strikes or other interruptions in the major producing fields abroad. Shipments of relatively small tonnages have continued with some regularity to the Caribbean region (the West Indies and Central America, including the Bahamas, the Virgin Islands, and Panama), where American exporters have a natural advantage in distance over foreign competitors. Exports to this market were a little over 2,000,000 tons annually before the World War, but the growing use of fuel oil has since reduced its use of coal materially. Exports of bituminous coal to the Caribbean region amounted to 409,000 tons in 1934, or 84 percent more than shipments in 1933. The increase in 1934 was due chiefly to larger shipments to Cuba, which gained approximately 170,000 tons (144 percent). Shipments to the Virgin Islands increased from 15,549 tons in 1933 to 25,840 tons in 1934 (66 percent). Exports to Panama decreased about 5 percent.

Exports of bituminous coal overseas in 1934 increased about 12 percent over the previous year. These shipments went chiefly to South American countries, of which Brazil, Argentina, and Uruguay are the principal customers for United States coals. In round numbers shipments in 1934 to Argentina were 35,000 net tons, an increase of 28 percent; to Brazil 136,000 tons, an increase of 44 percent; and to Uruguay 29,000 tons, an increase of 8 percent.

Imports.—Except in years when domestic supplies have been curtailed by strikes or other causes imports of bituminous coal are small and have slight influence on the domestic market. During the depression bituminous imports have declined greatly from the 1924–29 average of about 500,000 net tons and in 1934 amounted to only 179,661 tons, a decrease of 8.6 percent from 1933. Canada is the chief source of bituminous imports. Canadian shipments to the United States come principally from the mines of British Columbia and enter this country through the customs ports of Washington, Montana, and Idaho. Some coal from the Eastern Provinces of Canada is also received in the New England States. Imports of coal from the United Kingdom, which had grown from about 3,000 net tons in 1931 to 52,000 tons in 1933, were 49,808 tons in 1934, a decrease of about 4 percent from the preceding year.

PRODUCTION BY STATES AND FIELDS

With few exceptions all States contributed to the total increase in the output of bituminous coal in 1934, Michigan and Montana taking the lead in rate of increase, followed by Pennsylvania and Virginia, among the important States. Even in Alaska more coal was mined. Michigan gained 55 percent in production; Montana's tonnage rose nearly 21 percent, and that of Pennsylvania and Virginia, 12.5 and 11.3 percent, respectively. Texas and Utah registered the only material losses.

Within the administrative areas established by the bituminous-coal code all divisions recorded growth, ranging from 2.2 percent in division IV to 8.6 in division II. Division I, which accounts for almost three-fourths of the country's production, increased its output 7.7 percent in the year, virtually identical with the 7.4-percent total gain. There was little change from 1933 to 1934 in the relative percentage of the total output produced by the various code divisions. According to preliminary figures for 1934, division I increased its percentage of the total output by 0.16 percent, division II by 0.18 percent, and division III by 0.03 percent. Slight losses in percentage of the total were recorded in division IV and V, amounting to 0.12 and 0.25 percent, respectively.

Comparison of bituminous coal produced, 1929 and 1932–34, by States

State	Production (net tons)				Increase or decrease, percent	
	1929	1932	1933	[1] 1934	1929–34	1933–34
Alaska	100,610	102,700	96,467	112,000	+11.3	+16.1
Alabama	17,943,923	7,856,939	8,759,989	9,596,000	−46.5	+9.5
Arkansas	1,695,108	1,033,471	882,924	2,264,000 (Arkansas and Oklahoma)	−58.6	+6.7
Oklahoma	3,774,080	1,255,466	1,238,244			
Colorado	9,920,741	5,598,721	5,229,767	5,168,000	−47.9	−1.2
Illinois	60,657,641	33,474,553	37,413,145	40,905,000	−32.6	+9.3
Indiana	18,344,358	13,323,573	13,761,052	14,820,000	−19.2	+7.7
Iowa	4,241,069	3,862,435	3,194,983	3,345,000	−21.1	+4.7
Kansas	2,975,971	1,952,885	2,217,622	5,800,000 (Kansas and Missouri)	−17.2	+2.7
Missouri	4,030,311	4,069,598	3,432,212			
Kentucky:						
Eastern	46,025,452	25,759,534	28,265,332	30,175,000	−34.4	+6.8
Western	14,437,148	9,540,048	7,834,397	7,893,000	−54.3	+.7
Maryland	2,649,114	1,428,937	1,530,748	1,660,000	−37.3	+8.4
Michigan	804,869	446,149	406,584	631,000	−21.6	+55.2
Montana	3,407,526	2,125,225	2,152,207	2,600,000	−23.7	+20.8
New Mexico	2,622,769	1,263,386	1,226,236	1,250,000	−52.3	+1.9
North Dakota	1,862,130	1,739,658	1,782,272	1,770,000	− 4.9	−.7
South Dakota	12,854	49,074	59,375	60,000	(2)	+1.1
Ohio	23,689,477	13,909,451	19,588,763	20,842,000	−12.0	+6.4
Pennsylvania	143,516,241	74,775,862	79,295,944	89,223,000	−37.8	+12.5
Tennessee	5,405,464	3,537,882	3,774,761	4,056,000	−25.0	+7.5
Georgia	44,636	27,208	41,382	47,000 (Georgia and North Carolina)	−51.5	+8.3
North Carolina	52,180	1,900	2,014			
Texas	1,100,668	636,590	821,878	[3] 716,000	−34.9	−12.9
Utah	5,160,521	2,852,127	2,674,986	2,418,000	−53.1	−9.6
Virginia	12,748,306	7,692,180	8,178,642	9,100,000	−28.6	+11.3
Washington	2,521,327	1,591,426	1,394,068	1,387,000	−45.0	−.5
West Virginia	138,518,855	85,608,735	94,343,535	98,190,000	−29.1	+4.1
Wyoming	6,704,790	4,170,963	4,013,167	4,349,000	−35.1	+8.4
Other States	20,454	23,196	17,837	18,000	−12.0	+.9
Total United States	534,988,593	309,709,872	333,630,533	358,395,000	−33.0	+7.4

[1] Subject to revision.
[2] Indicated increase of doubtful significance, because of small tonnages involved.
[3] Since these preliminary figures were prepared, telegraphic reports have been received giving production of 2 additional mines which would raise the State of Texas in 1934 to 759,000.

Monthly trend of production by code authority areas.—Figure 42 pictures the trend of production, by months, in 1933 and 1934 within the divisional boundaries set up by the coal code.

The break-down, by months, is based on information derived from serveral sources. The data for 1933 are highly accurate, as the basis was the final complete returns to the Bureau from all mines known to produce more than 1,000 tons a year. The monthly apportionment of this total was made possible in some instances by direct tonnage reports from the operators to the code authorities or the State mine inspectors or to local operators' associations but in most instances by the use and analysis of figures of railroad carloadings and waterway shipments.

For 1934 virtually the reverse method was used. A final total for the year is not yet available, as returns from the operators to the Bureau are not complete at present. The preliminary figure of total tonnage is largely the result of the sum of data for the 12 months, which were obtained from some of the operators themselves, supplied to the Bureau direct or to the code authorities and to the State offices

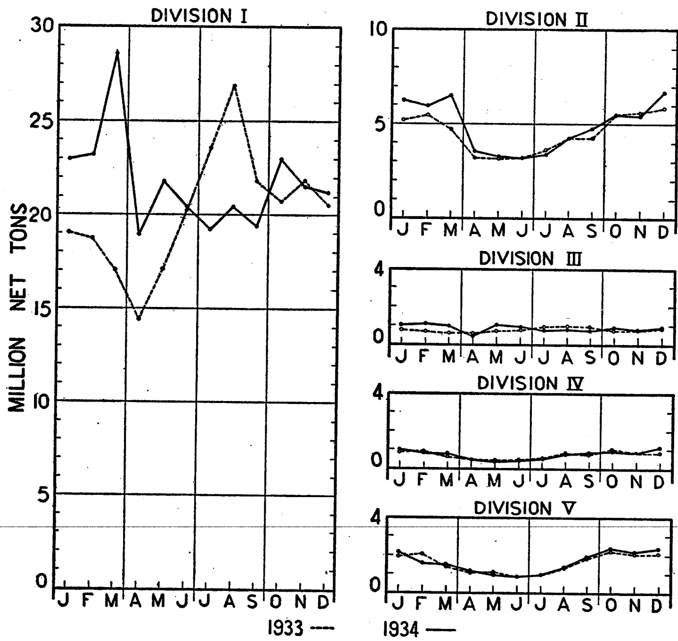

FIGURE 42.—Monthly production of bituminous coal, by Code Authority Divisions, 1933-34.

and associations, and, of course, from railroad-car loadings and waterway shipments for the year, as in 1933.

TREND OF MINE CAPACITY

Trend of capacity.—The capacity of the soft-coal mines continues to follow a downward course, as is shown in figure 43. The diagram presents the capacity of the active mines from 1899 to 1933. The curve of "Full-time capacity" indicates what the mines in operation could do with the same equipment and labor if they produced for 308 days at the rate at which they actually produced on the days they were operating. Coal really is loaded 308 or more days every year, and many individual mines are active as much as 308 days. It is not possible, however, for all mines to attain so high a record because of delays and consequent loss of time incident to the maintenance and operation of property—such as break-downs, falls of roof, or failure of power supply—and because of the seasonal character of the market. For these reasons the more conservative figure of capacity at 280 days is also shown, which was suggested some years ago by the coal committee of the American Institute of Mining and Metallurgical Engineers.

Capacity increased rapidly in the period before the World War, and the rate of increase was accelerated greatly by the high price level from 1916 to the early part of 1923. This growth was especially rapid just after the war, as labor was readily obtainable at the high wages then prevailing, and thousands of new mines were opened. The peak was reached in 1923, when the mines active in that year had an annual 308-day capacity of 970,000,000 tons.

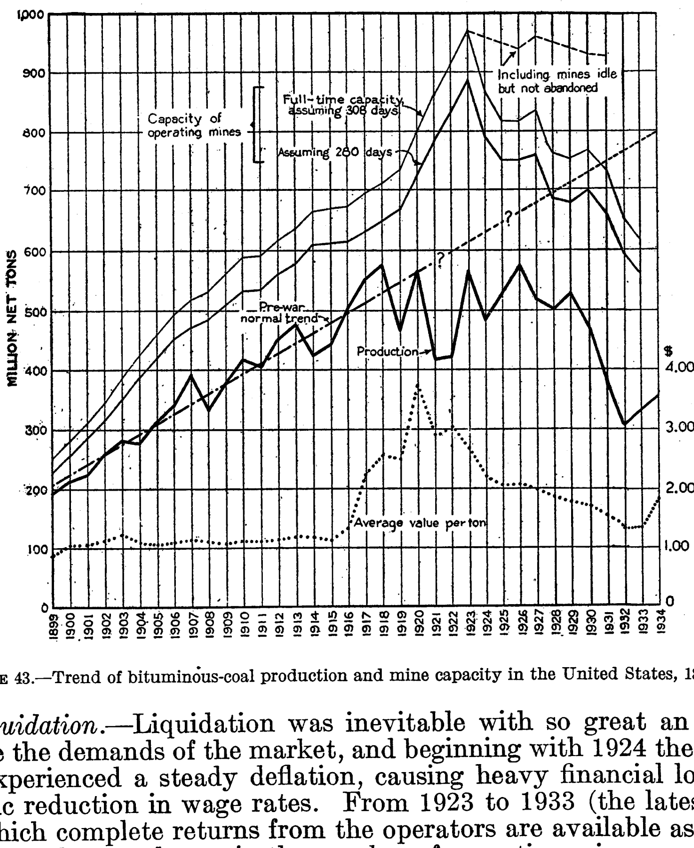

FIGURE 43.—Trend of bituminous-coal production and mine capacity in the United States, 1899–1934.

Liquidation.—Liquidation was inevitable with so great an excess above the demands of the market, and beginning with 1924 the industry experienced a steady deflation, causing heavy financial loss and drastic reduction in wage rates. From 1923 to 1933 (the latest year for which complete returns from the operators are available as this is written), the net change in the number of operating mines—commercial mines, not wagon mines—was 3,776, and the net reduction of operating capacity was 355,000,000 tons.

In 1933 there were 128 more mines active than in 1932. The figure relates only to mines of "commercial" size, as defined by the Bureau of Mines—that is, mines producing over 1,000 tons a year. The increase was due in part to new operations and in part to reopening of mines which had been closed during the depression. Despite the increased number of pits there was a further decrease in the calculated capacity, which fell to 593,000,000 tons, the lowest point since 1911. The full explanation of the indicated decrease in the calculated capacity is not yet at hand, but among the causes were the limitation upon overtime work and the clean-up system and the reduction in established working hours in some districts, which were effected by the code.

Capacity in 1934.—Statistics of the capacity in operation during 1934 are not yet available. It is known that there has been a material increase in number of operating mines, particularly in small truck mines which have flourished under the more remunerative prices brought by the code. This factor and the further reopening of mines shut down earlier in the depression acted to increase capacity. On the other hand, the adoption of the 7-hour day and 35-hour week tended to decrease capacity. Evaluation of the net results of these

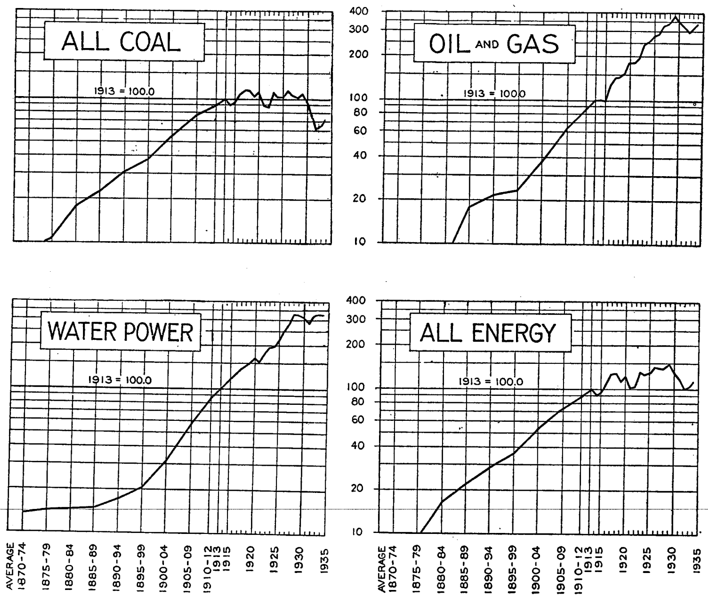

FIGURE 44.—Relative rate of growth of annual supply of coal, oil and gas, and water power in the United States, 1870–1934.

opposing tendencies must await completion of the mine reports for 1934.

An illustration of the fact that expansion of capacity may continue locally, even during a period of acute depression, is seen in the record of the newly developed Grundy field in Buchanan County, Va. The field is served by an extension of the Norfolk and Western Railway, which took over and rebuilt an old logging railroad. Production began on a small scale at 2 mines in 1932. In 1933 there were 5 mines in operation, with an output of 278,853 tons. In 1934 the number of mines increased to 7 and the output to 573,217 tons.

COMPETITIVE SOURCES OF POWER

The total supply of energy made available to consumers in the United States in 1934 in the form of coal, oil, natural gas, and water power was approximately 20,292 trillion B. t. u. compared with 19,317 trillion in 1933, a gain of 5 percent. All sources shared in the increase except water power, which suffered a slight decline of 1.9 percent, associated with the western drought. Total coal increased 8 to 9 percent, domestic oil less than 1 percent, imported oil about 12 percent, and natural gas about 6 percent. Trends of the principal groups of energy sources and of the total energy supply are shown in figure 44.

To compare the relative values of the different sources of energy the figures are expressed in British thermal units, as some common denominator is necessary to express such unlike quantities as tons of coal, barrels of oil, and cubic feet of gas. Water power is represented by the equivalent of the fuel necessary to perform the same work, assuming a low thermal efficiency. It is important to note that the figures for "domestic oil" represent the entire production of crude petroleum. They include, therefore, not only the energy used in the form of fuel oil under boilers, and consequently competing more or less directly with coal, but also that used in the form of gasoline, kerosene, and other refined products. Even these refined products involve a measure of indirect competition with coal, as the energy market of the country is becoming more fluid and competitive and a demand which cannot be met by one source of supply tends to fall back on the others. Thus, the eventual exhaustion of one source of energy will be met by the remaining sources. In the short-time view, the principle is illustrated in degree by minor shifts in usage governed by current changes in the availability of the several energy sources, which are largely reflected in price movements.

On the basis of production in 1918 the energy supply in 1934 represented 93 percent of the amount made available in the former year.

In the peak year 1929 the percentage relative to 1918 was 121. On the same basis the output of bituminous coal in 1934 was 62 percent of the 1918 production compared with 92 percent in 1929. Although bituminous coal has lost heavily to its competitors in the energy market for several years, particularly during the depression years, it remains the principal source of the energy supply of the United States. In 1934 the share of bituminous coal in the total energy supply was 46.3 percent compared with 45.2 percent in 1933, halting the downward trend of this factor which had continued without interruption since 1926. The strongest competitor of bituminous coal for the energy market—domestic oil—accounted for 26.9 percent of the total in 1934 compared with 28.1 percent in 1933. The share of natural gas in the total energy supply remained virtually unchanged in 1934, as did that of imported oil, while the percentage of the total contributed by water power declined from 10 in 1933 to 9.3 in 1934.

Energy supply in 1934, by sources

	Trillion B. t. u.	Percent		Trillion B. t. u.	Percent
Anthracite	1,561	7.7	Natural gas	1,774	8.7
Bituminous coal	9,390	46.3	Water power, fuel equivalent	1,896	9.3
Domestic oil [1]	5,456	26.9			
Imported oil [1]	215	1.1		20,292	100.0

[1] Total crude.

Fuel oil.—The production of residual fuel oil at American refineries showed a slight gain of 1 percent in 1934 compared with an increase of 7.4 percent in the output of bituminous coal. Figures showing the consumption of fuel oil in 1934 are not available in detail, but the data for some of its larger uses will indicate the trend. Locomotives of class I railroads, for example, consumed 44,133,000 barrels of fuel oil in 1934 compared with 40,370,000 in 1933, an increase of 9.3 percent. Consumption of coal by locomotives was 66,039,519 tons in 1933 and 70,321,539 tons in 1934, a gain of 6.5 percent. For bunkers of ships engaged in foreign trade 29,898,642 barrels of fuel oil were used in 1934, a decline of 7.4 percent from the preceding year. Coal for foreign bunkers gained 0.4 percent in 1934. Electric central stations used 4.4 percent more fuel oil in 1934 than in 1933 while they used 9.7 percent more coal.

A development of large potential consequence in the transportation field was the experimental appearance in 1934 of the lightweight stream-lined passenger train operated by Diesel-engine power. Important economies in operating cost are claimed for this type of equipment, and the possibility of its extended use for rail transportation is of considerable interest to competitive sources of railway motive power.

No official data showing the use of oil for heating houses are yet available, but a valuable indicator of the consumption trend is found in the figures showing annual shipments of oil burners. Sales of oil burners for domestic use increased about 10 percent in 1934, according to figures collected by the Bureau of the Census from manufacturers who produced approximately 88 percent of the total value of the output of the industry in 1933. That coal men and stoker manufacturers have not been idle in meeting this competition is revealed by the census data furnished by manufacturers representing about 91 percent of the total value of the output of stokers in 1933. Sales of residential and apartment stokers in 1934 reached the total of 25,496, an increase of 65.4 percent over 1933.

Water power.—Electricity produced by water power in 1934 declined 1.9 percent from 1933, largely because of the drought. The total production of electricity for public use in 1934 was 6.7 percent greater than in the preceding year. Hydroelectricity accounted for 37.4 percent of the total production of electricity in 1934, a reduction from its share of 40.7 percent in 1933. The decrease in the production of electricity by water power was due chiefly to losses in the West Nroth Central States and in the South Atlantic States. Together these two groups were responsible for about two thirds of the total decrease in 1934.

Natural gas.—Final figures showing the production and consumption of natural gas in 1934 are not available, but according to preliminary estimates production was about 6 percent greater than in 1933. Consumption by electric public utilities amounted to 127,896,000,000 cubic feet, an increase of 24.6 percent over 1933. The largest contribution to the increase in the use of natural gas in central electric plants in 1934 was in the Pacific Coast States where consumption was 73.8 percent larger than in 1933. The use of natural gas for the production of electricity increased 27.8 percent in the East North Central States—Ohio, Indiana, Illinois, Michigan, and Wisconsin; 23.9 percent in the West North Central States—Minnesota, Iowa, Missouri, the Dakotas, Nebraska, and Kansas; and 12.8

percent in the West South Central States—Arkansas, Louisiana, Oklahoma, and Texas. The Middle Atlantic and South Atlantic States are not large users of natural gas for producing electricity, but the quantities consumed in these groups in 1934 declined 55.4 and 44 percent, respectively, from 1933.

Statistics compiled by the American Gas Association show a gain of 12.1 percent in 1934 in the aggregate quantity of natural gas sold for domestic, commercial, industrial, and miscellaneous uses. Sales for domestic use declined 1.7 percent, while those for commercial use gained 6.3 percent, for industrial use 21.1 percent, and for miscellaneous uses 39 percent. Gas for industrial purposes constituted 61 percent and that for domestic purposes 31 percent of the total sold.

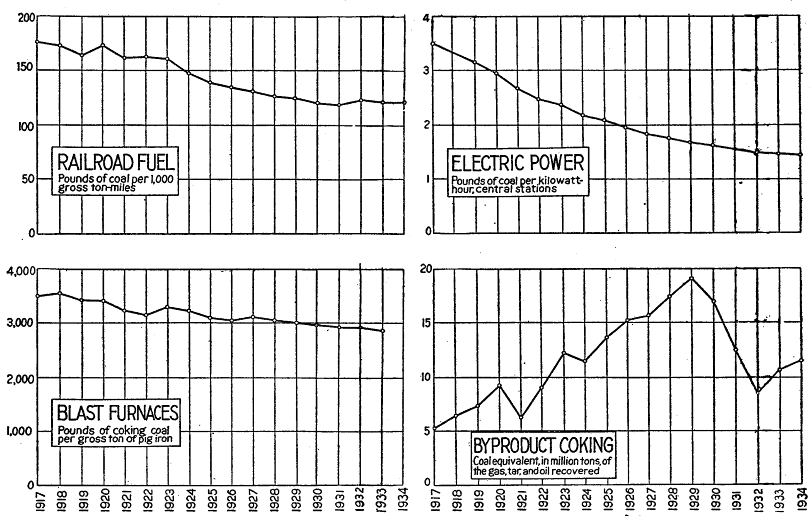

FIGURE 45.—Trends in fuel efficiency in the United States, 1917–34.

TREND OF FUEL EFFICIENCY

Competition from other sources of power has not been the only factor in checking the growth in the demand for coal. Stimulated by the high prices of coal during and immediately following the World War particularly by the run-away prices of 1920, the fuel-economy movement made rapid strides during the next several years with cumulative savings to large users of coal amounting to many millions of tons. Figure 45 shows graphically the trend of fuel efficiency in some of the larger consumer groups from 1917 to 1934. It could not be expected that the rate of growth in fuel efficiency would continue at the pace recorded in its earlier history when opportunities for economies had been little explored, and the record of recent years clearly indicates a slower rate of growth and, in some instances, at least a temporary halting in the progress of efficiency in the use of coal.

Railroad fuel.—An upturn in the unit of consumption of coal by locomotives in freight service was recorded again in 1934, similar to but smaller than the upturn in 1932. The average consumption of coal per 1,000 gross ton-miles by locomotives in freight service was 122 pounds compared with 121 pounds in 1933 and 119 pounds in 1931, the year of best performance. The average coal consumption per passenger-train car-mile remained stationary at 15.2 pounds. Since 1920 the unit of consumption in freight service has been lowered 29.9 percent and that in passenger service 19.1 percent. The slackening rate of growth of the fuel-economy movement in railroad service is illustrated by the record by periods since 1920. From 1920 to 1925, the net reduction in the number of pounds of coal consumed per 1,000 gross ton-miles in freight service was 34 pounds, an annual average of 6.8 pounds; from 1925 to 1930 the net reduction was only 19 pounds, an annual average of 3.8 pounds, while in 1934 there was a net increase of 1 pound over 1930.

Electric public utilities.—Economies in the utilization of fuel for power generation at electric central stations present the most striking and consistent record of growth in fuel efficiency. The number of pounds of fuel consumed by steam-electric stations per kilowatt-hour of electricity generated declined from 3 in 1920 to 1.45 in 1934, a decrease of 51.7 percent, and the unit of quantity has been consistently smaller in each succeeding year of the period named. Here, too, the rate of improvement in fuel efficiency has decreased in recent years. The consumption of fuel per kilowatt-hour in 1925 was 0.9 pound (30 percent) less than in 1920, representing an average annual decline of 0.18 pound; consumption in 1930 was 0.48 pound less than in 1925, a reduction of 23 percent and an average yearly decline of 0.096 pound; and the quantity consumed in 1934 was 0.17 pound less than in 1930, a net decrease of 10.5 percent in the 4-year period, or an average annual reduction of 0.043 pound.

Blast furnaces.—The consumption of coal per gross ton of pig iron and ferro-alloys produced declined from 3,420.8 pounds in 1920 to 2,875.7 pounds in 1933, a reduction of 545.1 pounds (15.9 percent). The reduction from 1932 to 1933 was 35.1 pounds (1.2 percent) compared with a reduction of only 0.4 percent in the previous year. The trend of coal saving in the iron and steel industry since the war, as shown by the reduction in pounds of coking coal required per ton of pig iron and ferro-alloys, was as follows:

	Net reduction	Reduction	Average yearly reduction
From—	*Pounds*	*Percent*	*Pounds*
1918 to 1923	253.7	7.1	50.74
1923 to 1928	270.0	8.1	54.00
1928 to 1933	177.7	5.8	35.54

MECHANICAL CLEANING OF BITUMINOUS COAL

Growth in total tonnage of bituminous coal cleaned mechanically.—Although mechanical aid had been employed to remove impurities from coal at the mines for many years, accurate records of the total tonnage thus treated are not available for the years prior to 1906, when the quantity cleaned mechanically at mines was approximately 9,252,000 net tons. Since then this total has risen consistently and amounted to 35,747,000 tons in 1934. Data covering this step in the preparation of coal for the market have been published by the Bureau of Mines in preliminary form for 1934 in a study by L. N. Plein which includes the figures for the intervening years since 1929, the latest year for which the data were previously available. The study also brings up to date the figures showing the quantity washed at central cleaning plants operated by consumers, completing the record of this tonnage which began with 1927 and showing a grand total of 39,720,000 tons of coal cleaned mechanically in 1934. A noteworthy fact revealed by the record is the increase in the percentage of the total production represented by the tonnage cleaned mechanically which has persisted throughout the depression years. The rise has been consistent from 6.9 percent in 1929 to 11.1 percent in 1934. The figures for 1934 are preliminary and subject to revision. They were published first, together with those for 1930–33, in the Bureau's Weekly Coal Report 930, of May 11, 1935.

Tonnages cleaned by wet and pneumatic methods.—The trend of mechanical cleaning at central plants and at the mines by wet and pneumatic methods is shown in figure 46. From a total of 36,799,000 tons in 1929 the quantity of coal cleaned mechanically by wet and pneumatic methods in the United States increased to 38,800,000 tons in 1930, declining to 36,172,000 tons in 1931 and to 30,278,000 tons in the low-production year 1932. Mechanical cleaning increased

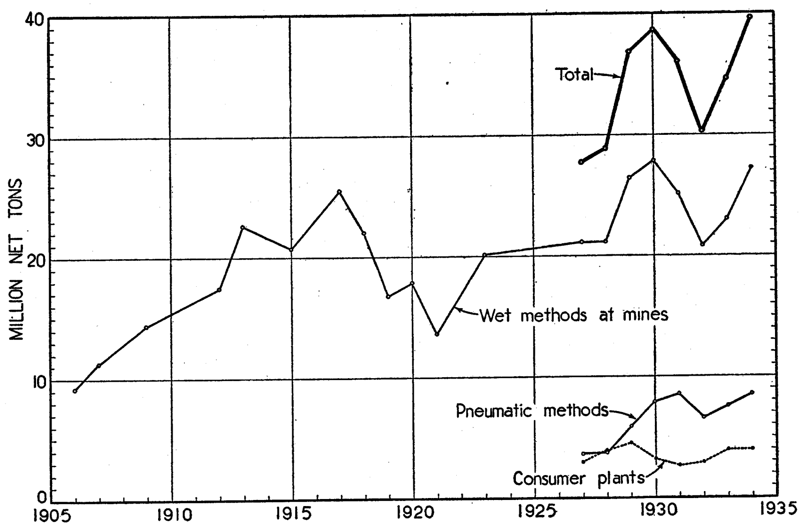

FIGURE 46.—Tonnage of bituminous coal cleaned mechanically, 1906–34.

decisively thereafter to a total of 34,558,000 tons in 1933 and 39,720,000 in 1934. The record for 1934 represents a gain of 31.2 percent over that at the depth of the depression and of 7.9 percent over the boom year 1929. The increasing relative importance of mechanical cleaning during this period is revealed by the percentage of total output handled by cleaning plants, as follows: 1929, 6.9 percent; 1930, 8.3 percent; 1931, 9.5 percent; 1932, 9.8 percent; 1933, 10.4 percent; and 1934, 11.1 percent. During the same period cleaning by wet methods at the mines increased from 26,428,000 tons in 1929 to 27,259,000 in 1934, or 3.1 percent. On the other hand, wet cleaning at central washeries operated by consumers declined 12.2 percent, chiefly because of reduced activity at three large plants serving steel works. The total quantity of coal cleaned by wet methods increased 0.9 percent from 1929 to 1934, while the tonnage cleaned by pneumatic methods increased 45.2 percent during the same period. The quantities cleaned by various methods in 1934 were as follows: By wet methods at the mines, 27,259,000 tons, and at central washeries operated by consumers, 3,973,000 tons; by pneumatic methods at the mines, 8,488,000 tons.

Types of cleaning equipment in use.—The types of equipment used for mechanical cleaning of coal, grouped into general classes, are as follows:

	Net tons cleaned in 1934	Percent of total cleaned in—	
		1934	1929
Wet methods:			
Jigs	13,769,000	34.7	51.4
Concentrating tables	1,115,000	2.8	9.6
Jigs in combination with concentrating tables	1,153,000	2.9	3.3
Launders and upward-current classifiers	15,190,000	38.2	19.3
Unspecified	5,000		.5
Total wet	31,232,000	78.6	84.1
Pneumatic methods	8,488,000	21.4	15.9

The total production of the mines served by cleaning plants was 90,751,000 tons in 1934 compared with 74,607,000 in 1929.

Of the total raw coal treated at cleaning plants in 1934, 91.4 percent of the product was clean coal and 8.6 percent refuse, virtually the same as in 1929. From 1929 to 1934, inclusive, the percentage of refuse has ranged from 9 percent in 1930 to 8 in 1932. The number of cleaning plants in operation has not changed greatly since 1929, but there has been a gradual increase in the average annual output per cleaning plant, particularly since 1932.

Mechanical cleaning by States.—Pennsylvania, with 15,658,000 tons, led in quantity of coal cleaned mechanically in 1934, followed in order by West Virginia (including Virginia) with 10,951,000 tons, and Alabama with 7,110,000 tons. Illinois and Indiana together cleaned 2,325,000 tons, and Ohio and Michigan together 1,261,000 tons. In percentage of State output cleaned mechanically, Alabama was the leader, as it has been for many years, with 74.1 percent; Washington cleaned 28.7 percent of its total output and Pennsylvania 17.5 percent. To avoid disclosing individual operations it is necessary in some instances to group the State figures. With this modification the tonnages of coal cleaned mechanically are shown by States for 1934 as follows:

	Net tons		*Net tons*
Alabama	7,110,000	Pennsylvania	15,658,000
Colorado	417,000	Tennessee	357,000
Illinois, Indiana	2,325,000	Washington	398,000
Kentucky	308,000	West Virginia, Virginia	10,951,000
Missouri, Kansas	778,000	Other States	157,000
Ohio, Michigan	1,261,000	Total	39,720,000

The record for the period 1929–34 reveals a consistent increase in mechanical cleaning in Illinois-Indiana, Kansas-Missouri, and Ohio-Michigan, an increase of over 4,500,000 tons in Pennsylvania and of 3,300,000 tons in the Virginias.

Custom washeries.—The custom washery, an interesting development of recent years, is not connected directly with mine-operating companies or consumers. Coal is received from mines of various companies cleaned for a certain basic charge, and then disposed of to numerous consumers. The function of the custom washery would appear to lie in service to certain coal fields with numerous mines too small to finance individual washeries but able to share the expense of a central washing plant. A few such plants are in existence at present, and their experience may guide further developments in this field.

PENNSYLVANIA ANTHRACITE

THE MARKET IN 1934

Production.—The production of Pennsylvania anthracite was 57,385,000 net tons in 1934 according to preliminary figures. This represents an increase of 15.8 percent over 1933 and the first interruption in the downward trend of annual production that had continued since 1926.

The increased production in 1934 may be explained largely by the severe winter weather in the principal anthracite-consuming areas of the Eastern States during the early months of the year, compared with especially mild temperatures in the corresponding period of 1933. January production was 6,125,000 tons, the largest monthly figure since October 1931 and 60 percent above the same month in 1933. Low temperatures continued to stimulate production in February

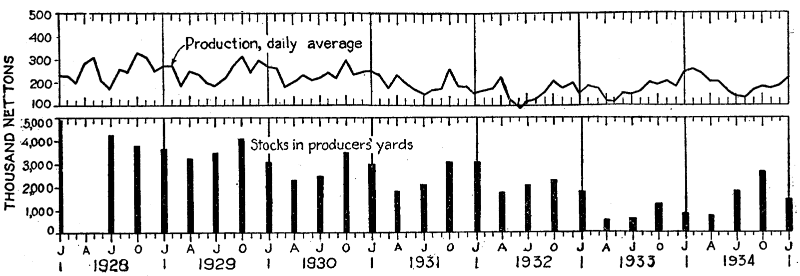

FIGURE 47.—Trends of production and stocks of Pennsylvania anthracite, 1928–34.

and March, and the total for the first quarter was 46 percent above that in 1933 and accounted for nearly one third of the output for the year. The rate of production continued well above that of the previous year throughout the second quarter, the total exceeding that of 1933 by approximately 45 percent. With ample stocks on hand at the mines, in retail yards, and on lake docks and little demand for heating, production declined materially in the third quarter and was, in fact, 16 percent below that for the same period in 1933. October production was approximately the same as in the previous year, but in November (with relatively higher temperatures than in 1933) output fell below that of November 1933 by 13 percent. December production exceeded the same month in 1933 by about 6 percent, but the fourth quarter showed a loss of about 3 percent compared with the preceding year.

A reported development in the producing fields was the large increase in the production of so-called "bootleg" coal, taken without permission from lands owned or leased by the established producers and delivered to market by truck. The Anthracite Institute has estimated that this production was 3,000,000 tons in 1934. Accurate figures of course cannot be obtained, but it is clear that the bootleg tonnage constitutes a substantial addition to the official statistics of production.

Statistical summary of monthly developments in the Pennsylvania anthracite industry in 1934

[All tonnage figures represent thousands of net tons]

	1934													1933 total
	January	February	March	April	May	June	July	August	September	October	November	December	Total	
Production, including mine fuel, local sales, and dredge coal:														
Monthly total	6, 125	5, 952	6, 418	4, 837	5, 250	4, 184	3, 443	3, 584	3, 977	4, 729	4, 181	4, 705	57, 385	49, 541
Average per working day	236	253	238	202	202	161	138	133	166	182	174	188	189	164
Shipments, breakers and washeries only:[1] Monthly total, all sizes	5, 189	5, 198	5, 355	4, 173	4, 491	3, 495	2, 974	3, 110	3, 401	4, 027	3, 601	4, 214	49, 228	43, 022
Distribution:														
Lake loadings	--------	--------	--------	42	176	122	97	60	73	28	9	--------	607	425
Receipts at Duluth-Superior	--------	--------	--------	--------	68	64	33	20	30	6	8	--------	229	135
Shipments from Lake docks	43	37	28	19	61	57	24	37	61	49	45	71	532	541
New England receipts—														
By tide (includes imports)	126	104	166	171	154	158	130	109	126	106	144	116	1, 610	1, 690
By rail	543	459	571	259	323	295	304	246	324	341	347	370	4, 382	3, 562
Exports	108	110	98	79	140	100	92	98	101	136	134	102	1, 298	1, 035
Imports	42	33	48	46	25	25	48	38	56	32	49	36	478	456
Industrial consumption by—														
Railroads (class I only)	167	137	164	146	140	123	118	118	126	143	144	158	1, 684	1, 513
Electric-power utilities	141	150	138	123	137	150	154	158	137	151	139	145	1, 723	1, 470
Stocks at end of period shown:														
Railroads (class I only)	156	156	148	150	150	155	148	145	145	142	141	132	132	156
Electric-power utilities	1, 316	1, 292	1, 309	1, 316	1, 320	1, 307	1, 318	1, 272	1, 265	1, 285	1, 305	1, 250	1, 250	1, 323
Stocks on Lake docks	215	180	154	143	243	318	377	402	390	396	366	296	296	257
Retail stocks, 283 representative dealers	591	403	386	510	658	709	761	759	786	757	746	702	702	607
Producers' stocks	725	316	308	690	1, 165	1, 541	1, 769	2, 197	2, 506	2, 673	2, 540	1, 921	1, 921	1, 106
Prices at mines, average per net ton:[2]														
Company stove	$7. 25	$7. 25	$7. 25	$6. 50	$6. 25	$6. 50	$6. 75	$7. 00	$7. 25	$7. 25	$7. 25	$7. -5	$6. 98	$6. 98
Company buckwheat no. 1	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25	$3. 25
Retail prices (average 25 cities):[3]														
Stove	$13. 44	$13. 46	$13. 46	$13. 14	$12. 53	$12. 60	$12. 79	$13. 02	$13. 25	$13. 32	$13. 25	$13. 22	$13. 12	$13. 18
Chestnut	$13. 25	$13. 27	$13. 27	$12. 94	$12. 34	$12. 40	$12 60	$12. 83	$13. 05	$13. 11	$13. 04	$13. 02	$12. 93	$12. 97
Wholesale prices, index numbers (1926=100)[4]	81. 5	81. 2	81. 2	78. 1	75. 7	76. 9	78. 6	79. 9	81. 3	82. 0	82. 1	82. 3	80. 1	82. 2
Labor conditions:[4]														
Index of employment (1929 average=100)	64. 1	63. 2	67. 5	58. 2	63. 8	57. 5	53. 6	49. 5	56. 9	58. 5	60. 7	61. 6	59. 6	51. 7
Index of pay-roll totals (1929 average=100)	73. 2	65. 8	82. 4	51. 7	64. 0	53. 3	42. 3	39. 7	47. 0	48. 3	51. 2	52. 3	55. 9	45. 8

[1] As reported by the Anthracite Bureau of Information.
[2] Quoted by trade journals in New York market.
[3] Bureau of Labor Statistics, white ash, sidewalk delivery.
[4] Bureau of Labor Statistics index numbers.

Weather conditions.—Since anthracite is used chiefly for heating buildings the market during the heating season is controlled principally by temperature levels. With the advent of colder weather in the northeastern region than had been experienced in recent previous years and new records for low temperatures in February in most of the area, demand for anthracite was exceptionally strong during the first part of the year. During April temperatures were more nearly normal, being slightly below normal in some areas and slightly above in others. At the beginning of the heating season in September monthly mean temperatures were above normal in the New England and Middle Atlantic States, where the bulk of the anthracite output is consumed. Colder weather reversed this situation in October, when temperatures were below normal and below the levels of the previous year. November temperatures in the heavy consuming regions were generally well above normal, but December averages again were below normal, especially in New York State and New England.

Trend of stocks.—At the end of the first quarter the heavy consumer demand had sharply reduced producers stocks to only 308,000 tons. These were built up gradually to 2,673,000 tons by the end of October and were 1,921,000 at the end of the year, an increase of 73.7 percent over the quantity on hand a year earlier.

Stocks on the upper lake docks had reached a low level of 143,000 tons by the end of April, as against 286,000 tons a year earlier. With the opening of the lake shipping season stocks were replenished gradually until they reached the high point of 402,000 tons at the end of August. At the end of the year stocks on the lake docks were 296,000 tons, 15.2 percent above the quantity on hand at the end of 1933.

The total stocks of anthracite carried by retail dealers is not known. However, the trend of retail stocks may be indicated by the reports furnished by a group of dealers believed to be representative of the industry as a whole. These figures show that the low point of the year was reached at the end of March, with a gradual increase to the high point at the end of September, and that the level at the end of the year was 15.7 percent above that a year earlier.

Railroad stocks of anthracite and those carried by electric public utilities are more stable than other commercial stocks. In 1934 the stocks of class I railways began the year at 156,000 tons, remained at that high level of the year at the end of both January and February, and declined to the low point of the year—132,000 tons—at the end of December. Anthracite stocks held by electric utilities, which were 1,323,000 tons on January 1, ranged throughout the year between that figure and the low of 1,250,000 tons reached on December 31, a decrease of 5.5 percent during the year.

Consumption.—As has been indicated already, consumption of anthracite increased materially in 1934. The calculated total is 55,751,000 tons compared with 49,589,000 tons in 1933, an increase of 12.4 percent. The estimated consumption takes into account imports, exports, and changes in stocks in producers' storage yards.

Distribution.—Lake shipments of anthracite improved greatly in 1934, the loadings at lower Lake Erie ports amounting to 607,000 tons, or an increase of 42.8 percent over 1933. Receipts at Duluth-Superior docks also showed a large increase—229,000 tons, or 69.6 percent above those of the previous year. Shipments off the lake docks for the year, however, declined 1.7 percent from those of 1933.

Tidewater receipts of anthracite in the New England States (including imports) declined 4.7 percent in 1934, but receipts by rail increased by 23 percent. The total New England receipts during the year were 14 percent above those in 1933. While no definite data are available to show the distribution of anthracite to the Middle Atlantic States, the most important market, it is apparent that this region received much more substantial shipments than in 1933.

Exports.—An encouraging feature of the anthracite market in 1934 was the substantial increase of 25.4 percent in exports.

Canada is by far the leading foreign market for Pennsylvania anthracite, and until recent years the United States supplied virtually all of this fuel used in Canada. The recent downward trend in exports to Canada may be attributed largely to increasing competition from other fuels and from British anthracite. In response to these influences exports to the Dominion had been declining steadily from the 1929 figure of 3,376,303 tons, but in 1934 the decline was halted by a substantial increase. Exports to Canada were 1,266,462 net tons in 1934, an increase of 23.3 percent over 1933, and constituted about 98 percent of the total exports. Canadian imports of anthracite from Great Britain increased rapidly, until in 1933 they exceeded Canadian imports from the United States. In 1934 the United States regained some of its former position in the Canadian market, when figures of the Dominion Government showed a total of 1,804,127 tons received from this country compared with 1,643,516 tons from Great Britain.

In addition to the Canadian market small quantities of anthracite are shipped to the Caribbean region with some regularity and to various other markets more or less intermittently. In 1934 Italy again appeared as a customer for American anthracite, shipments of 18,162 tons to that country being the first of consequence for many years. Newfoundland and Labrador took 5,003 tons of anthracite in 1934, a reduction of 17.5 percent from the previous year. Cuba received 4,658 tons as against 56 tons in 1933. Colombia received 1,126 tons in 1934, and various other countries received small lots.

Imports.—Imports of anthracite in 1934 were 478,118 net tons as against 456,252 tons in 1933, an increase of 4.8 percent. As in 1933, Soviet Russia was the principal source of imported anthracite, furnishing about 67 percent of the total and increasing its shipments 41 percent over those in the previous year. Imports from Soviet Russia were 323,326 tons. Receipts from the United Kingdom were 152,694 tons, a decline of 23 percent from the previous year. Canada was the only other contributor, with a total of 2,098 tons.

On April 2 the United States Court of Customs and Patent Appeals rendered a decision holding that anthracite imports from Great Britain and Germany in 1932 were exempt, under the "most-favored-nation" clause of existing treaties, from payment of the tax of 10 cents per 100 pounds provided in the Revenue Act of 1932. In June the court upheld the application of this tax on imports of coal from Soviet Russia in 1932.

Competitive fuels.—Besides the burden of increasing costs of production with the progressive development of the field and the depletion of the more accessible and regular seams the anthracite industry has been subjected during the past several years to the steadily increasing competition of other fuels in fields where it was once supreme. Bituminous coal, byproduct coke, oil, and gas are the chief competitors of

Pennsylvania anthracite for domestic heating, with fuel briquets, beehive coke, gas-house coke, petroleum coke, anthracite and semi-anthracite produced in other States, and imported fuels playing less important roles in the competition for this important market.

There are no recent data showing the quantity of bituminous coal used for domestic heating. It is estimated that the annual total ranges from 56,000,000 to 77,000,000 tons. Bituminous coal is easily accessible to anthracite-consuming territory, but definite information is lacking as to its share in the domestic heating market for such territory. The use of byproduct coke for domestic heating has grown rapidly in recent years and in 1933 reached the peak of 10,215,360 tons, a gain of 287.3 percent over 1923. In 1934, however, sales of byproduct coke for domestic use decreased slightly (0.4 percent) from those of the previous year. Beehive coke sold for domestic use amounted to 346,181 tons in 1934, an increase of 25.6 percent over 1933.

Data on the production of domestic heating oils in 1934 are not available at present. In 1933 sales of range oils were 9,849,000 barrels, an increase of 44 percent over 1932. Sales of other light fuel oils in 1933, the last year for which data are available at present, reached a total of 34,140,000 barrels, an increase of 16.7 percent over 1932 and of 579.9 percent over 1924. Further increase in 1934 is indicated by estimates from trade sources and by the increased shipments of oil burners for domestic use. Sales of burners in 1934 were 83,654 units, an increase of 10.4 percent over 1933.

Sales of natural gas for domestic use declined 1.7 percent in 1934, according to figures published by the American Gas Association, while total sales of manufactured gas for domestic use and for house-heating increased 2.4 percent over 1933. Sales of manufactured gas for domestic use declined 1.9 percent from the previous year, while sales for househeating increased 53.1 percent.

The production of briquets, a fuel used entirely for domestic heating in this country, totaled 704,856 tons in 1934, an increase of 32.9 percent over 1933. Sales of gas-house coke were 513,200 tons in 1934, an increase of 3 percent. Production of petroleum coke declined 17.7 percent (to 1,300,000 tons) in 1934, while production of hard coal outside of Pennsylvania increased 14.8 percent to a total of 402,000 tons.

The quantity of bituminous coal used for domestic heating is an unknown factor; however, compared with the total of other solid fuels available for the domestic heating market Pennsylvania anthracite improved its position in 1934 with an increase over 1933 of more than 15 percent as against a slight decline in the total of other solid fuels. A further sign of improvement in the position of anthracite in the domestic heating field is the increase of 65.4 percent in sales of mechanical stokers for use in residences and apartments in 1934. The increase in oil prices in 1934 compared with average prices of anthracite which remained at approximately the levels of the previous year, also would tend to improve the position of anthracite in competitive territory.

Prices.—Circular prices of anthracite averaged about the same as in 1933 and were firm during the cold weather in the early months of the year. Buckwheat was even reported sold at a premium in the extreme cold weather of February. After the close of the heavy-demand season, however, maintenance of price levels appeared to be increasingly difficult on account of ample stocks and slack demand.

Trade reports indicate that the price situation was very unsettled throughout the summer months and well into early winter.

Although a number of large producers had announced in March that winter prices would be held until May 1 the slackening demand led to abandonment of this program, and early in April a reduction of $1 per ton on the senior sizes was announced, to go into effect on April 10. Successive increases of 25 cents per ton in the circular prices of line companies for these sizes were put into effect on the first of the month in June, July, August, and September, restoring the levels that prevailed during the first quarter of the year. On October 1 an additional increase of 25 cents was added to the price of pea-size coal.

Notwithstanding the reported instability of anthracite mine prices during the greater part of the year, the average value per ton at the

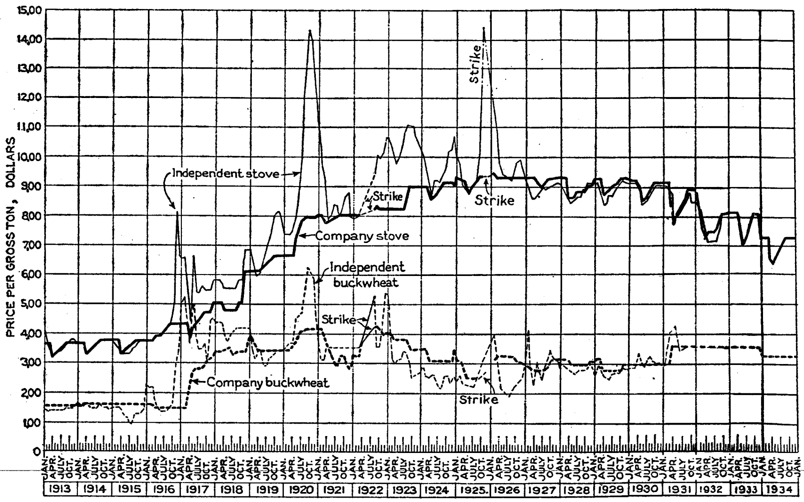

FIGURE 48.—Monthly prices of Pennsylvania anthracite, f.o.b. mine, as quoted by the trade journals, 1913–34. Prices are averages of the range, as quoted on the New York market.

mines apparently increased in 1934 over the previous year. A preliminary estimate based on returns from the larger companies indicates that the average value of shipments, local sales, and colliery fuel in 1934 was $4.24 per ton compared with $4.17 in 1933.

The average retail price of stove-size anthracite in 25 representative cities, as reported by the Bureau of Labor Statistics, declined from $13.18 in 1933 to $13.12 in 1934. In the same cities the average price of chestnut size dropped from $12.97 in 1933 to $12.93 in 1934.

Labor conditions.—According to the Pennsylvania Department of Mines the number of men employed at the anthracite mines in 1934 was 106,251, an increase of 3,782 men (3.7 percent) over the comparable figure for the previous year. This is an encouraging feature of the upturn in anthracite demand in 1934 but is far from accounting for the 150,000 men employed at the anthracite mines as late as 1930. An important factor in the situation is the increased output per worker that has characterized production in recent years, largely as the result of the growth of stripping, increased mechanization of underground operations, improvement of mining practices, and centralization of operating activities. From 1929 to 1933 the output per man per day increased from 2.17 to 2.60 tons (19.8 percent). The net result is that, for the near future at least, fewer men than formerly will be required to produce a given tonnage.

Strikes of relatively short duration over disagreements of local significance occurred at various collieries in the anthracite region during 1934. The most serious suspension resulted from the strike called in the northern field on January 15 by the United Anthracite Miners of Pennsylvania, a rival organization to the United Mine Workers of America. Some of the collieries in Luzerne County were closed down by the strike, but conditions were reported close to normal at the end of January. The strike was ended officially on February 12 when the questions at issue were referred for investigation to the Anthracite Board of Conciliation and an umpire selected by the National Labor Board.

WORLD PRODUCTION

An indication of continued improvement in industrial activity among the leading nations of the world is afforded by the record of their coal production in 1934. Following an increase of 4.1 percent in 1933 over 1932, the world production of coal recorded a further gain of 8.1 percent in 1934 and was the largest since 1930. Preliminary figures compiled by the Bureau of Mines give the world production of coal of all grades in 1934 as 1,267,000,000 metric tons. Of this quantity,[5] 184,000,000 tons (about 15 percent) were lignite and 1,083,000,000 tons bituminous and anthracite. Production of lignite increased 7 percent in 1934, and the output of bituminous and anthracite gained 8.3 percent over the preceding year.

Without exception the leading industrial nations increased their production of coal in 1934 over their respective outputs in 1933. The total increase in tonnage is accounted for chiefly by the three large producing countries—the United States, Germany, and Great Britain—which together produced about 73 percent of the total gain. Relative to 1933, however, the largest increases were represented by the outputs of Soviet Russia in Europe, Canada, and Spain. Following an increase of 23 percent in 1933 the coal production of Soviet Russia in Europe registered a further increase of 20 percent in 1934 and reached a total 118 percent greater than that in 1929. In both Canada and Spain production of coal increased about 16 percent in 1934. The coal production of the United States in 1934 gained 8.5 percent over the previous year and constituted 29.8 percent of the world total, virtually the same ratio as in 1933. The only country of industrial importance to suffer a loss in its 1934 production of coal was the Netherlands, whose output declined about 2 percent from that of 1933.

The following table of production by countries is based upon information from official sources at present available, supplemented by information from trade sources. The figures for 1934 are subject to revision.

[5] Does not include lignite produced in the United States, for which separate figures are not available.

Coal produced in the principal countries of the world in the calendar years 1932, 1933, and 1934, in thousands of metric tons [1]

[Prepared by L. M. Jones, Bureau of Mines]

Country	1932	1933	1934
North America:			
Canada:			
Coal	7,507	7,741	9,610
Lignite	3,142	3,057	2,905
United States:			
Anthracite	45,228	44,943	52,059
Bituminous and lignite	280,963	302,663	325,129
Other countries	692	652	(2)
South America	1,785	2,187	(2)
Europe:			
Belgium	21,424	25,300	26,363
Czechoslovakia:			
Coal	10,961	10,532	10,800
Lignite	15,858	15,063	15,300
France:			
Coal	46,262	46,873	} 48,745
Lignite	1,012	1,068	}
Germany: [3]			
Coal	104,741	109,921	125,011
Lignite	122,647	126,796	137,256
Saar [4]	10,438	10,561	11,318
Hungary:			
Coal	895	800	} 7,400
Lignite	5,931	5,907	}
Netherlands:			
Coal	12,756	12,574	[5] 12,400
Lignite	124	97	(2)
Poland:			
Coal	28,835	27,356	[6] 28,300
Lignite	33	33	[6] 25
Spain:			
Coal	6,854	5,999	[7] 7,000
Lignite	336	301	[7] 300
Europe—Continued.			
United Kingdom:			
Great Britain	212,083	210,436	224,500
U. S. S. R. (Russia):			
Coal } Lignite }	53,600	66,000	79,300
Other countries	12,939	11,919	(2)
Asia:			
China	[8] 28,000	[8] 27,000	(2)
India, British	20,477	20,107	[8] 20,500
Japan (including Taiwan and Karafuto):			
Coal	29,817	34,100	} (2)
Lignite	109	116	}
Other countries	16,150	16,282	(2)
Africa:			
Southern Rhodesia	438	484	[6] 636
Union of South Africa	9,921	10,714	12,195
Other countries	333	333	(2)
Oceania:			
Australia:			
New South Wales	6,893	7,233	7,800
Other States	4,449	4,626	(2)
New Zealand:			
Coal	943	857	[8] 900
Lignite	928	993	[8] 1,000
Total	1,126,000	1,172,000	1,267,000

[1] 1 metric ton equivalent to 2,204.6 pounds.
[2] Estimate included in total.
[3] Exclusive of mines in the Saar under French control.
[4] Mines under French control.
[5] Estimated on the basis of 11 months' figures.
[6] Estimated on the basis of 10 months' figures.
[7] Estimated on the basis of 9 months' figures.
[8] Approximate production.

The encouraging continuation in 1934 of the upward trend in world coal production begun in 1933 lends interest to comparison of the record of the leading countries in 1934 with 1932, the low point of the depression, and 1929, the year of peak production. The comparison with 1929 should not obscure the fact that world production of coal in 1934 represented a gain of 12.5 percent over the output in 1932 and was only 6.6 percent below the average for the 10 preceding years. The following table shows the percentage change in the coal production of leading countries in 1934 from that in 1932 and 1929:

Percentage change in coal production, by leading countries

Country	Percent of change in 1934 from— 1932	1929
United States	+15.6	−31.7
Canada	+17.5	−21.2
Poland	−1.9	−38.8
Germany:		
Coal	+19.4	−23.5
Lignite	+11.9	−21.3
Union of South Africa	+22.9	−6.3
Japan		
Belgium	+23.1	−2.1
India, British	+0.1	−13.8
Great Britain	+5.9	−14.3
France	+3.1	−11.3
Netherlands	−3.7	+5.6
Soviet Russia in Europe	+47.9	+118.0
Czechoslovakia:		
Coal	−1.5	−34.6
Lignite	−3.5	−32.2
World	+12.5	−18.8

It will be noted that, except for small deficiencies in Poland, the Netherlands, and Czechoslovakia, most of the leading countries have made substantial gains in their outputs over those in 1932. The 1934 production in most countries was, of course, still substantially below

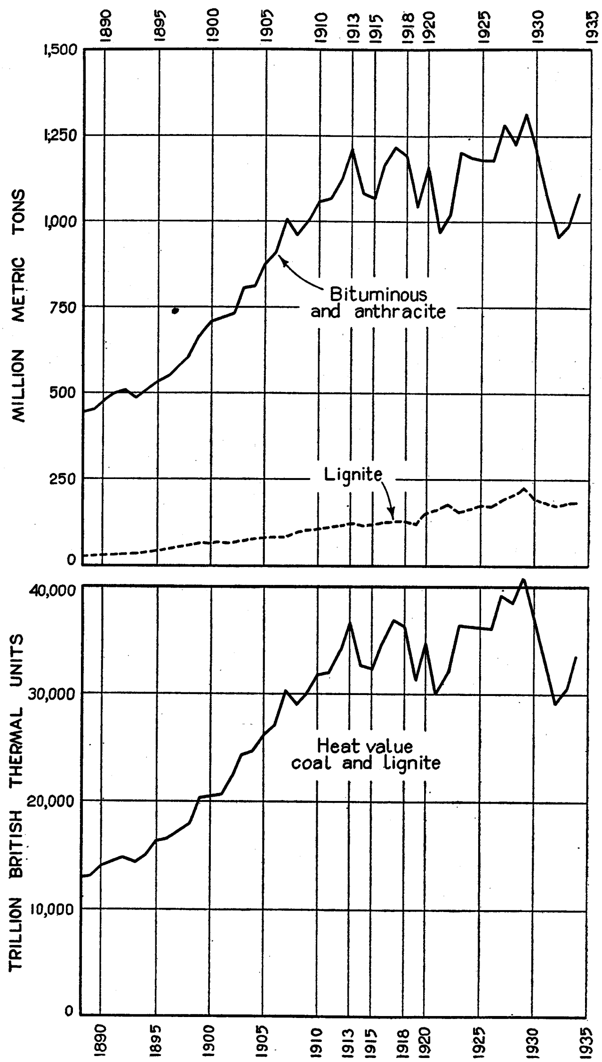

FIGURE 49.—World production of coal and lignite, 1890–1934.

the figures of the high-record year 1929. The notable exception is Soviet Russia in Europe, where intensive efforts to augment coal supplies have been made. The 1934 production of the Netherlands is also notable for an increase of 5.6 percent over the output in 1929.

COKE AND BYPRODUCTS

By L. N. Plein, W. H. Young, and H. L. Bennit

SUMMARY OUTLINE

The total value of all the products of the coke industry in 1934 was $263,270,382, a gain of $45,643,599 (21 percent) over 1933. Production of coke was 31,821,576 net tons, an increase of 15.3 percent over 1933. Byproduct ovens operated at 49.2-percent capacity compared with 33.6 percent in 1932 and 42.7 percent in 1933.

The average price of byproduct coke increased 12 percent from $4.51 in 1933 to $5.05 in 1934. The average value of beehive coke increased 30 percent from $2.90 in 1933 to $3.77 in 1934. The average price of coal charged increased from $3.38 per ton in 1933 to $3.70 in 1934. The amount of coal needed to make 1 ton of byproduct coke was 1.44 tons, and the cost was $5.33 compared with 1.45 tons costing $4.90 in 1933. The amount of coal needed to make 1 ton of beehive coke was 1.59 tons and the cost was $2.64 compared with 1.61 tons costing $2.13 in 1933. (See fig. 56.)

The increase of 15.3 percent in coke production is due partly to the increase of 20.4 percent in pig-iron production. Production of byproduct coke at furnace plants was 19,241,850 net tons, an increase of 19.2 percent over 1933. This directly reflects the increase of pig-iron production in 1934.

Although the total production of coke in 1934 was only 53.1 percent of that for the peak year of production—1929—it is significant to note that the trend has been definitely upward since the low of 1932, when the production was only 36.3 percent of the 1929 output. Compared with a 10-year trend the output in 1934 was 71.1 percent of the average annual production of 44,701,773 net tons from 1924 to 1933. In 1933 the output was 57.7 percent of the average annual production (47,640,607 tons) for 1923 to 1932. (See fig. 50.)

The ever-growing importance of byproduct ovens for the manufacture of coke is indicated by the large number of beehive ovens reported as abandoned in each year—2,594 in 1932, 2,733 in 1933, and 2,841 in 1934. In 1934, 4,114,675 tons more by product coke were produced than in 1933, but the output of beehive coke was only 117,707 tons higher.

The total value of products resulting from carbonization of coal in byproduct ovens (coke, byproducts, and breeze) was $259,365,410 compared with $164,199,585, the total cost for coal charged into coke ovens, representing an enhancement of $95,165,825 in value or 57.5 percent above the cost of the raw material.

Sales of domestic coke, which have grown steadily and consistently up to and including 1933, remained about the same in volume in 1934 as in 1933. (See fig. 53.) Sales of domestic coke in 1932 were 1,134,883 tons higher than in 1931, and sales in 1933 were 860,837 tons higher than in 1932, but sales in 1934 were only 29,258 tons

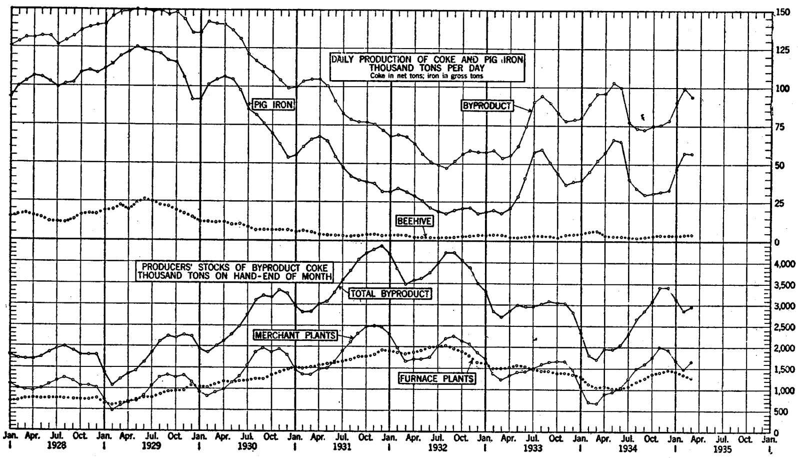

FIGURE 50.—Average daily production of beehive and byproduct coke and of pig iron; also producers' stocks of byproduct coke, 1928–35, by months.

higher than 1933. Domestic coke at byproduct ovens was $5.12 per ton in 1933 and $5.83 per ton in 1934.

STATISTICAL SUMMARY

TABLE 1.—*Salient statistics of the coke industry in 1934*

	Byproduct	Beehive	Total
Coke produced:			
At merchant plants:			
Quantity net tons	11, 550, 961		11, 550, 961
Value	$70, 968, 519		$70, 968, 519
At furnace plants:			
Quantity net tons	19, 241, 850		19, 241, 850
Value	$84, 577, 011		$84, 577, 011
Total:			
Quantity net tons	30, 792, 811	1, 028, 765	31, 821, 576
Value	$155, 545, 530	$3, 880, 144	$159, 425, 674
Screenings or breeze produced:			
Quantity net tons	2, 730, 641	50, 140	2, 780, 781
Value	$5, 691, 136	$24, 828	$5, 715, 964
Coal charged into ovens:			
Quantity net tons	44, 342, 998	1, 635, 294	45, 978, 292
Value	$164, 199, 585	$2, 714, 987	$166, 914, 572
Average value per ton	$3. 70	$1. 66	$3. 63
Average yield in percent of coal charged:			
Coke	69. 44	62. 90	69. 21
Breeze (at plants actually recovering)	6. 16	6. 31	6. 16
Ovens:			
In existence Jan. 1	13, 053	16, 857	29, 910
In existence Dec. 31	12, 963	14, 206	27, 169
Dismantled during year	90	2, 841	2, 931
In course of construction Dec. 31			
Daily capacity of ovens Dec. 31 net tons	171, 937	(1)	(1)

1 Data not available.

TABLE 1.—*Salient statistics of the coke industry in 1934*—Continued

	Byproduct	Beehive	Total
Coke used by operator:			
In blast furnaces:			
Quantity ... net tons	13,836,635		13,836,635
Value	$59,148,953		$59,148,953
For other purposes:			
Quantity ... net tons	1,476,500	563	1,477,063
Value	$8,124,608	$1,604	$8,126,212
Disposition of coke:			
Sold for furnace use to affiliated corporations:			
Quantity ... net tons	1,067,847	44,036	1,111,883
Value	$4,775,553	$290,991	$5,066,544
Merchant sales of furnace coke:			
Quantity ... net tons	952,605	126,559	1,079,164
Value	$4,992,057	$435,487	$5,427,544
Sold for foundry use:			
Quantity ... net tons	1,077,216	184,923	1,262,139
Value	$6,873,908	$855,293	$7,729,201
Sold for domestic use:			
Quantity ... net tons	10,174,114	346,181	10,520,295
Value	$59,274,945	$1,163,910	$60,438,855
Sold for manufacture of water gas:			
Quantity ... net tons	587,438	69,296	656,734
Value	$3,492,164	$224,104	$3,716,268
Sold for industrial and other use:			
Quantity ... net tons	986,045	249,816	1,235,861
Value	$5,277,658	$884,949	$6,162,607
Disposition of screenings or breeze:			
Use by operator:			
For raising steam:			
Quantity ... net tons	1,826,996	16	1,827,012
Value	$3,648,287	$54	$3,648,341
To make producer or water gas:			
Quantity ... net tons	101,966		101,966
Value	$401,673		$401,673
Other purposes:			
Quantity ... net tons	168,238	1,140	169,378
Value	$289,420	$1,335	$290,755
Sold:			
Quantity ... net tons	675,967	17,426	693,393
Value	$1,441,570	$12,926	$1,454,496
Average receipts per ton sold:			
Furnace coke (merchant sales)	$5.24	$3.34	$5.03
Foundry coke	$6.38	$4.63	$6.12
Domestic coke	$5.83	$3.36	$5.74
For manufacture of water gas	$5.94	$3.23	$5.66
Other industrial coke	$5.35	$3.54	$4.99
Screenings or breeze	$2.13	$0.74	$2.10
Stocks on hand on Jan. 1, 1935:			
Furnace ... net tons	922,108	3,133	925,241
Foundry ... do	51,069	8,373	59,442
Domestic and other ... do	2,584,481	29,379	2,613,860
Breeze ... do	438,447	8,015	446,462
Imports ... do			160,934
Exports ... do			942,785
Calculated consumption ... do			30,306,000
Byproducts produced:			
Gas ... M cubic feet	493,581,751		493,581,751
Wasted ... percent	1.6		1.6
Burned in coking process ... do	35.6		35.6
Surplus sold or used ... do	62.8		62.8
Tar ... gallons	408,710,314		408,710,314
Ammonium sulphate or equivalent ... pounds	959,820,592		959,820,592
Crude light oil ... gallons	115,694,748		115,694,748
Yield of byproducts per ton of coal:			
Gas ... M cubic feet	11.13		11.13
Tar ... gallons	9.22		9.22
Ammonium sulphate or equivalent ... pounds	22.29		22.29
Crude light oil ... gallons	2.90		2.90
Value of byproducts sold:			
Gas (surplus)	$59,258,839		$59,258,839
Tar:			
Sold	$10,760,125		$10,760,125
Used by producer	$5,262,916		$5,262,916
Ammonium sulphate or equivalent	$8,731,509		$8,731,509
Crude light oil and derivatives	$13,217,529		$13,217,529
Other byproducts [2]	$897,826		$897,826
Total value of coke, breeze, and byproducts [3]	$259,365,410	$3,904,972	$263,270,382

[2] Includes naphthalene and tar derivatives.
[3] Includes value of tar used by the coke plants.

TABLE 2.—*Statistical trends of the coke industry, 1923 and 1931–34*

	1923	1931	1932	1933	1934
Coke produced:					
Beehive net tons	19,379,870	1,128,337	651,888	[1] 911,058	1,028,765
Byproduct do	37,597,664	32,355,549	21,136,842	26,678,136	30,792,811
Total do	56,977,534	33,483,886	21,788,730	[1] 27,589,194	31,821,576
Percent of total from byproduct ovens	66.0	96.6	97.0	[1] 96.7	96.8
Stocks of producers, end of year, all coke net tons	[2] 1,221,737	4,425,709	3,524,855	2,865,260	3,598,543
Exports, all coke do	1,237,342	754,302	630,151	637,819	942,785
Imports, all coke [3] do	85,002	103,563	117,275	160,873	160,934
Consumption, calculated, all coke do	55,173,457	31,705,322	22,176,708	27,771,843	30,306,382
Disposal of coke (beehive and byproduct):					
Furnace coke (including all coke used by producer) net tons	47,774,408	20,608,175	10,524,496	[1] 14,822,568	17,504,745
Foundry coke do	3,600,719	1,357,276	1,054,771	1,004,885	1,262,139
Other industrial (including water gas) net tons	2,283,888	1,838,566	1,295,290	[1] 1,836,987	1,892,595
Domestic coke do	2,733,414	8,495,317	9,630,200	10,491,037	10,520,295
Ovens:					
Beehive, in existence, end of year	62,349	21,588	19,440	[1] 16,857	14,206
Byproduct, in existence, end of year	11,156	13,108	13,053	13,053	12,963
Byproduct under construction, end of year	629				
Cost of coal charged, byproduct ovens, average per ton	$4.76	$3.55	$3.55	$3.38	$3.70
Prices of coke:					
Average spot price of Connellsville furnace coke, f. o. b. ovens	$5.33	$2.43	$2.04	$2.41	$3.77
Average realization on byproduct coke sold:					
Furnace coke (merchant sales)	$6.74	$4.59	$4.22	$4.00	$5.24
Foundry coke	$10.54	$6.11	$5.65	$5.34	$6.38
Other industrial (including water gas)	$9.06	$5.72	$5.26	$5.06	$5.57
Domestic	$9.05	$5.73	$5.21	$5.12	$5.83
Yield of byproducts per ton of coal charged:					
Tar gallons	8.1	9.62	9.84	9.39	9.22
Ammonium sulphate or equivalent pounds	21.2	24.33	23.06	22.18	22.29
Light oil gallons	2.7	3.03	2.94	2.79	2.90
Surplus gas sold or used M cubic feet	5.9	7.02	7.47	7.14	6.98
Average gross receipts of byproducts per ton of coke produced:					
Tar sold or used	$0.51	$0.637	$0.577	$0.506	$0.520
Ammonia and its compounds	$0.84	$0.441	$0.305	$0.269	$0.284
Light oil and its derivatives	$0.51	$0.447	$0.445	$0.461	$0.434
Surplus gas sold or used	$1.37	$2.084	$2.596	$2.099	$1.924
Total byproducts, including breeze	$3.48	$3.863	$4.182	$3.549	$3.372

[1] Revised figures.
[2] Furnace and foundry coke only.
[3] Prior to 1934 the figures represent general imports; beginning with 1934 they represent imports for consumption only.

Scope of report.—The continuing need for economy in public expenditure impels the Bureau of Mines to confine this report to presenting, through selected tables, the essential facts of the statistical record for the year. If not readily found any derivative figures carried in earlier reports will be furnished by the Bureau upon application.

The report covers only coke made by high-temperature carbonization of coal in beehive and byproduct ovens. However, byproduct coke produced by city gas companies is included. (See fig. 51.) The essential product of these companies is manufactured gas, but in 1934 the production of byproduct coke by city gas companies constituted nearly 11 percent of the national production of byproduct coke. With respect to ownership and accounting these byproduct ovens are part of the gas utility system, and the Bureau of the

Census therefore groups them within the manufactured-gas industry under the title "The Gas and Coke Industries." In other respects, however, these ovens form part of the byproduct-coke industry, and they are so included in the statistics of the Bureau of Mines. The differences in classification are followed advisedly by the Bureau of the Census and Bureau of Mines after consultation with leaders of the gas and coke industries, and the two offices have collaborated in the collection and analysis of the statistics. (See table 51.)

Coke is made by other processes not included in this chapter. In 1934, about 1,379,000 net tons of gas-house coke were made by high-temperature carbonization of coal in types of equipment other than

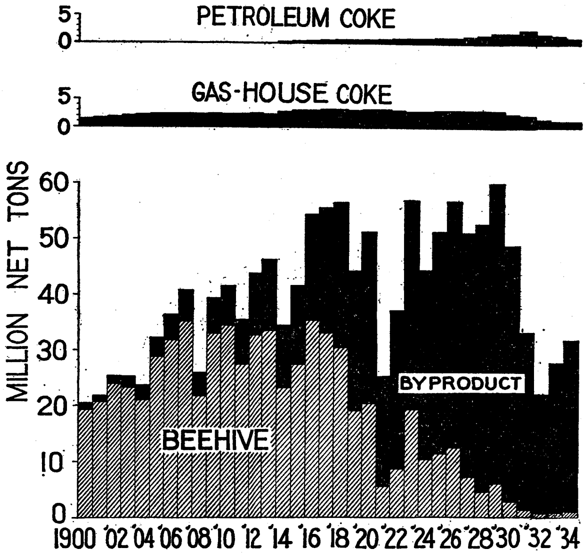

FIGURE 51.—Production of petroleum coke, gas-house coke, and beehive and byproduct coke in the United States, 1900–34. No figures on production of petroleum coke are available before 1914, when the production was 213,777 tons.

coke ovens—chiefly horizontal retorts. About 1,300,000 net tons of petroleum coke, a byproduct of petroleum refining, were produced in 1934. The manufacture of coke from coal-tar pitch is established on a commercial basis, but the tonnage produced is small. None of these kinds of coke are covered in this report. Only coke from byproduct and beehive ovens is adapted to blast-furnace and foundry uses, which consume the bulk of all coke produced. Practically, therefore, the coke trade is concerned only with beehive and byproduct-oven coke (fig. 51).

The standard unit of measurement in the coke industry is the short or net ton of 2,000 pounds, and unless otherwise specified this unit is employed throughout this report.

TABLE 3.—*Summary of coke produced, value, number of ovens, coal charged, and average yield, by States, in 1934*

[Exclusive of screenings or breeze]

State	Byproduct							Beehive						Total	
	Plants in existence	Ovens in existence [1]	Coal used (net tons)	Yield of coke from coal (percent)	Coke produced (net tons)	Value of coke at ovens: Total	Value of coke at ovens: Per ton	Ovens in existence [1]	Coal used (net tons)	Yield of coke from coal (percent)	Coke produced (net tons)	Value of coke at ovens: Total	Value of coke at ovens: Per ton	Coke produced (net tons)	Value of coke at ovens
Alabama	8	1,248	3,024,628	69.73	2,109,192	$6,508,933	$3.09							2,109,192	$6,508,933
Colorado	1	151	258,428	66.21	171,104	(2)	(2)	378	58,011	65.17	37,804	(2)	(2)	208,908	(2)
Connecticut	1	61	(3)	(3)	(3)	(3)	(3)							(3)	(3)
Illinois	8	950	2,445,816	67.46	1,649,907	9,071,800	5.50							1,649,907	9,071,800
Indiana	6	1,550	3,659,071	71.42	2,613,437	16,957,287	6.49							2,613,437	16,957,287
Kentucky	1	108	(3)	(3)	(3)	(3)	(3)							(3)	(3)
Maryland	1	361	1,100,271	71.30	784,539	(2)	(2)							784,539	(2)
Massachusetts	3	430	1,583,523	71.21	1,127,632	7,181,783	6.37							1,127,632	7,181,783
Michigan	9	674	3,610,917	70.56	2,547,747	14,348,536	5.63							2,547,747	14,348,536
Minnesota	3	196	609,738	68.46	417,447	(2)	(2)							417,447	(2)
Missouri	1	64	(3)	(3)	(3)	(3)	(3)							(3)	(3)
New Jersey	2	202	1,294,829	70.29	910,121	(2)	(2)							910,121	(2)
New York	9	1,024	5,862,685	69.76	4,089,708	25,283,246	6.18							4,089,708	25,283,246
Ohio	15	1,834	6,100,949	70.42	4,296,338	19,001,895	4.42							4,296,338	19,001,895
Oklahoma								100							
Pennsylvania	12	3,388	10,083,214	67.78	6,834,362	27,603,302	4.04	9,416	1,124,476	64.08	720,593	$2,554,813	$3.55	7,554,955	30,158,115
Rhode Island	1	65	(3)	(3)	(3)	(3)	(3)							(3)	(3)
Tennessee	1	24	100,984	69.91	70,598	375,581	5.32	429	12,502	47.94	5,993	23,422	3.91	76,591	399,003
Utah	1	56	194,161	60.47	117,401	(2)	(2)	819	25,153	52.49	13,203	(2)	(2)	130,604	(2)
Virginia								1,299	131,275	59.39	77,960	324,063	4.16	77,960	324,063
Washington	1	20	50,030	54.37	27,199	163,194	6.00	58	2,686	63.07	1,694	14,898	8.79	28,893	178,092
West Virginia	4	362	1,982,557	67.79	1,343,914	3,581,129	2.66	1,707	281,191	61.00	171,518	620,534	3.62	1,515,432	4,201,663
Wisconsin	2	195	(3)	(3)	(3)	(3)	(3)							(3)	(3)
Combined States			2,381,197	70.64	1,682,165	10,968,166	6.52							1,682,165	10,968,166
Undistributed						14,500,678	6.04					342,414	6.71		14,843,092
Grand total, 1934	90	12,963	44,342,998	69.44	30,792,811	155,545,530	5.05	14,206	1,635,294	62.90	1,028,765	3,880,144	3.77	31,821,576	159,425,674
Grand total, 1933 [4]	91	13,053	38,680,937	68.97	26,678,136	120,312,324	4.51	16,857	1,461,233	62.35	911,058	2,638,733	2.90	27,589,194	122,951,057
Change, 1934 percent	−1.1	−0.7	+14.6	+0.7	+15.4	+29.3	+12.0	−15.7	+11.9	+0.9	+12.9	+47.0	+30.0	+15.3	+29.7

[1] No new ovens were put into operation during the year, and no new ovens were under construction at the end of 1934.
[2] Included under "Undistributed."
[3] Included under "Combined States."
[4] Figures for beehive coke and for total coke revised since last report,

Production of coke.—The total production of coke was 31,821,576 tons in 1934 compared with 27,589,194 tons in 1933, an increase of 4,232,382 tons (15.3 percent). The production of byproduct coke was 30,792,811 tons, an increase of 15.4 percent over 1933, and the production of beehive coke was 1,028,765 tons, an increase of 12.9 percent over 1933. The leading States, in order of importance in the manufacture of byproduct coke, were Pennsylvania, Ohio, New York, Indiana, Michigan, and Alabama. The production of each of these States exceeded 2,000,000 tons of byproduct coke in 1934, and their combined output equaled 73 percent of the national production of byproduct coke. Pennsylvania and West Virginia lead in the production of beehive coke. Their combined output was 86.7 percent of the national production of beehive coke.

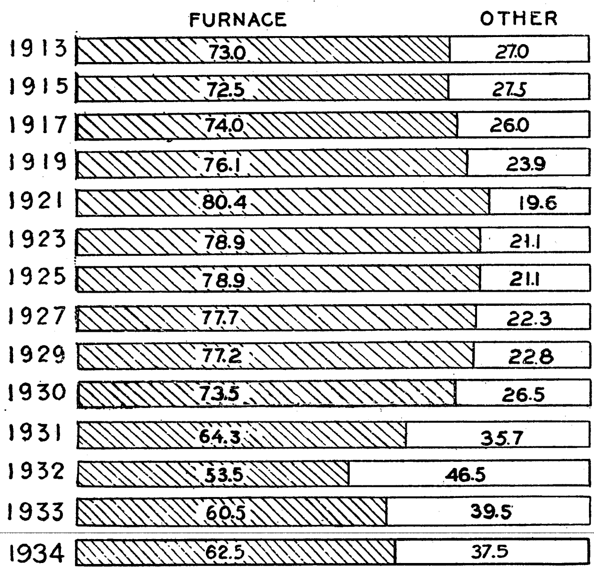

FIGURE 52.—Output of byproduct coke by furnace plants and by all other plants, 1913–34. Figures in bars represent percentage of the total produced during year.

Byproduct coke produced at plants classified as furnace plants totaled 19,241,850 tons, an increase of 3,097,682 tons over 1933. Byproduct coke produced at plants other than furnace plants was 11,550,961 tons, an increase of 1,016,993 tons over 1933. (See fig. 52.) The increase of coke production at furnace plants reflects the increased production of pig iron, which was 20.4 percent higher in 1934 than in 1933. Nonfurnace or merchant plants enjoy the greater stability of a diversified coke market, and the changes in production each year are not of the same magnitude as at furnace plants when there are widely fluctuating demands for pig iron. Nearly 30 percent of merchant byproduct coke is manufactured at plants owned by city gas companies. The production of coke at gas-company plants is fairly constant each year, and this has a stabilizing effect on the amount of merchant coke produced each year. Furnace-coke production, on the other hand, tends to vary with pig-iron production. Normally, the production of coke at furnace plants is nearly 80 percent of all byproduct coke made. In 1934, 62.5 percent of the byproduct coke was manufactured at furnace plants compared with 53.8 percent in 1932 and 60.5 percent in 1933. Table 10 shows the fluctuations in monthly production of coke at furnace plants compared with the fairly uniform monthly production at other plants.

Monthly production of coke increased from 2,443,000 tons in November 1933 to 3,254,300 tons in May 1934. Thereafter there was a steady decline to a low of 2,228,400 tons in September, followed by a gradual increase to 2,500,400 tons in December. Production in the early months of 1935 continued to trend upward (3,012,692 tons produced in March 1935). The monthly output of byproduct coke showed a similar trend. The production of beehive coke dropped sharply—from 166,200 tons in March to 73,700 tons in April and then to 45,400 tons in August—then rose gradually in the later months of the year. (See table 4 for monthly trends and daily averages.)

Value and price of coke.—The value of byproduct coke at the ovens was $155,545,530 in 1934, an increase of $35,233,206 (29.3 percent) over 1933 values. The value of beehive coke at the ovens was $3,880,144 in 1934, an increase of $1,241,411 (47 percent) over 1933. The increase in value of coke was due not only to increased production but also to higher unit prices. Byproduct coke rose from $4.51 per ton in 1933 to $5.05 per ton in 1934, and beehive coke from $2.90 to $3.77 per ton. The higher cost of coal charged in ovens ($3.31 in 1933 and $3.63 in 1934) is reflected in the higher prices for coke. Values and prices for the various grades of beehive and byproduct coke are shown in tables 28, 29, and 34. Average monthly prices (quoted by Steel) remained fairly uniform throughout the year in the 11 markets given in table 36.

Number and capacity of ovens.—At the end of 1934 there were 12,963 byproduct ovens and 14,206 beehive ovens in existence. No new ovens were completed during the year; however, 138 byproduct ovens constructed in 1931 were put into operation first in 1934. In 1934 90 byproduct ovens and 2,841 beehive ovens were abandoned. One byproduct plant, operated by a city gas company, ceased to operate during the year, when a supply of natural gas became available. The number of beehive ovens reported as abandoned grows larger in number each year; in 1934, 2,841 beehive ovens were abandoned as compared with 2,733 abandoned in 1933, and 2,594 in 1932. The number of beehive ovens has decreased from 60,432 at the end of 1924 to 14,206 at the end of 1934, indicating the increasing importance of byproduct ovens as the producers of coke for the nation.

Production of byproduct coke in 1934 was 49.2 percent of the calculated capacity of all byproduct ovens compared with 33.6 percent capacity in 1932 and 42.7 percent capacity in 1933. The high point of capacity utilized was 94 percent in May 1929. This peak month was followed by a persistent decline to a low of 27.4 percent in August 1932. Since then the trend of capacity used has been upward, reaching a high of 60.1 percent in May 1934 followed by a decline to 42.1 percent in September and then a gradual rise to 45.3 percent in December 1934. (See table 17.) At the end of 1934, if the byproduct coke ovens were operated at 90-percent capacity their potential output would be 56,500,000 tons of coke, nearly equaling the 59,883,845 tons of byproduct and beehive coke manufactured in the peak year 1929.

Coal charged in coke ovens.—In 1934, 45,978,300 tons of coal were charged into coke ovens; of this total, 44,343,000 tons were used in byproduct ovens and 1,635,300 tons in beehive ovens. The total cost of coal charged in byproduct ovens was $164,199,585 ($3.70 per ton), and the cost of coal for beehive ovens was $2,714,987 ($1.66 per ton). The cost of coal (1.44 tons) required to make 1 ton of byproduct coke was $5.33 in 1934 compared with $4.90 in 1933. Similarly the cost of coal (1.59 tons) required to make 1 ton of beehive coke rose from $2.13 in 1933 to $2.64 in 1934. (See table 19.)

The leading States mining coking coal, in relative order of importance, are West Virginia, Pennsylvania, and Kentucky. Of the 44,668,196 tons of coal purchased for use at byproduct plants, 40,688,777 tons (91 percent) were mined in West Virginia, Pennsylvania, and eastern Kentucky. (See table 22.)

The percent of coal cleaned mechanically before charging into byproduct ovens was 21.3 percent in 1934 compared to 21.5 percent in 1933. At beehive ovens the ratio of mechanically cleaned coal increased from 14.7 percent in 1933 to 24.8 percent in 1934.

Consumption of coke.—The indicated consumption of coke was 30,306,382 tons in 1934 compared with 27,771,843 tons in 1933. Iron furnaces used 16,183,070 tons (53.4 percent) of the coke consumed in 1934. (See table 26.)

The amount of byproduct coke used by the manufacturer of the coke was 15,313,135 tons, an increase of 13.9 percent over 1934. The amount of byproduct coke sold was 14,845,265 tons, an increase of 7.4 percent over 1933. The tonnage of furnace coke sold in 1934 was 64.5 percent higher than in 1933, the tonnage of foundry coke sold was 29.2 percent higher, and coke for industrial and other uses was 1.5 percent higher, but the tonnage sold for domestic use was down 0.4 percent. (See table 28.) The tonnage of beehive coke sold increased in all the grades, the increase in sales of domestic coke being 70,504 tons (25.6 percent) higher than in 1933.

Sales of domestic coke increased steadily each year from 6,332,720 tons in 1928 to 10,491,037 tons in 1933. (See fig. 54.) The sales of domestic coke in 1934 were 10,520,295 tons, only 29,258 tons greater than in 1933, compared to increases ranging from 470,000 to 1,200,000 tons during the period 1928 to 1933. Average prices of domestic coke at byproduct ovens dropped from $6.28 per ton in 1929 to $5.12 per ton in 1933 and rose to $5.83 per ton in 1934.

Stocks of coke.—On January 1, 1935, the total stocks of coke on hand were 3,598,543 tons, an increase of 733,283 tons over January 1, 1934. Stocks of furnace and foundry coke on January 1, 1935, were 15,647 tons lower than on January 1, 1934, but stocks of domestic and other grades were 748,930 tons higher.

Exports and imports.—Exports of coke were 942,785 tons valued at $5,419,738 in 1934 compared with 637,819 tons valued at $2,797,121 in 1933. Imports of coke were 160,934 tons in 1934, practically the same as in 1933, but the values increased from $483,722 to $864,851.

Coke-oven byproducts.—The volume of coke-oven gas produced in 1934 was 493,581,751 M cubic feet. This volume of gas was disposed of as follows: 175,868,523 M cubic feet were used for heating ovens, 309,571,357 M cubic feet of surplus gas were sold or used, and the balance (8,141,871 M cubic feet) had to be wasted. Surplus coke-oven gas (309,571,357 M cubic feet) was utilized as follows: 29,324,006

M cubic feet were used under boilers, and 119,716,459 M cubic feet were used in steel or other affiliated plants of the producer; 144,308,149 M cubic feet were distributed through city mains; and 16,222,743 M cubic feet were sold for industrial purposes. (See fig. 57.) Tables 45 and 46 show the amount of oven gas produced in 1933 and 1934 and the percentage changes for 1934 compared with 1933. The trend in the disposition of coke-oven gas is indicated by the relative amounts of coke oven gas used for various purposes. Comparing 1924 and 1934 the percentages of use were as follows (the first figure is for 1924): Used under boilers, 5.5 and 5.9 percent; used in steel or other related plants, 34.6 and 24.3 percent; distributed through city mains, 12.1 and 29.2 percent; sold for industrial purposes, 3.4 and 3.3 percent; used in heating ovens, 42.4 and 35.6 percent; and wasted, 2 and 1.7 percent.

The amount of ammonia produced, measured in terms of equivalent ammonium sulphate, was 959,820,592 pounds, an increase of 14.2 percent over 1933. Coke-oven tar produced in 1934 totaled 408,710,314 gallons, an increase of 12.5 percent over 1933. The production of crude light oil was 115,694,748 gallons in 1934, an increase of 19.7 percent over 1933.

Value and price of byproducts.—The total value of oven gas and byproducts was $92,865,828 in 1934. (See fig. 55.) Gas is, of course, the most important byproduct in point of value, followed by light oil and derivatives, tar and ammonia (table 43). The unit value of gas sold dropped from 20.3 cents per M cubic feet in 1933 to 19.1 cents in 1934; however, the much larger production of gas sold resulted in an increase in the total value from $55,997,694 in 1933 to $59,258,839 in 1934. The unit values of crude light oil and light oil derivatives in general were lower in 1934 than in 1933. The unit values of tar and ammonia were slightly higher. Due to increased production, the total values of light oils and derivatives, tar and ammonia, were higher in 1934 than in 1933 despite the lower unit prices.

COKE AND COKE BREEZE

MONTHLY AND WEEKLY PRODUCTION

TABLE 4.—*Byproduct, beehive, and total coke produced in the United States, 1931–34, by months, and average per day, in net tons*

Month	1931		1932		1933 [1]		1934	
	Total	Daily average	Total	Daily average	Total	Daily average	Total	Daily average
Byproduct:								
January	3,082,700	99,400	2,097,200	67,600	1,782,700	57,500	2,471,800	79,700
February	2,889,000	103,200	1,992,300	68,700	1,636,600	58,500	2,490,800	89,000
March	3,246,300	104,700	2,085,100	67,200	1,663,000	53,600	2,965,600	95,700
April	3,136,900	104,600	1,881,200	62,800	1,651,900	55,100	2,872,500	95,800
May	3,116,000	100,500	1,740,200	56,100	1,914,900	61,700	3,188,800	102,900
June	2,706,900	90,200	1,535,100	51,200	2,236,600	74,600	2,987,000	99,600
July	2,560,900	82,600	1,521,000	49,000	2,793,200	90,100	2,379,800	76,800
August	2,435,400	78,600	1,472,300	47,500	2,920,200	94,200	2,277,700	73,500
September	2,303,100	76,800	1,542,400	51,400	2,707,900	90,300	2,171,300	72,400
October	2,381,800	76,800	1,736,100	56,000	2,579,000	83,200	2,312,400	74,600
November	2,269,400	75,600	1,749,000	58,300	2,341,100	78,000	2,261,500	75,400
December	2,227,200	71,800	1,784,900	57,600	2,451,000	79,000	2,413,600	77,900
	32,355,600	88,600	21,136,800	57,800	26,678,100	73,100	30,792,800	84,400

[1] Figures for beehive coke and for total coke revised since last report.

TABLE 4.—*Byproduct, beehive, and total coke produced in the United States, 1931–34, by months, and average per day, in net tons*—Continued

Month	1931		1932		1933 [1]		1934	
	Total	Daily average	Total	Daily average	Total	Daily average	Total	Daily average
Beehive:								
January	144, 400	5, 300	73, 700	2, 800	89, 100	3, 400	111, 200	4, 100
February	144, 300	6, 000	72, 300	2, 900	91, 000	3, 800	133, 400	5, 600
March	132, 100	5, 100	73, 500	2, 700	100, 800	3, 700	166, 200	6, 200
April	96, 200	3, 700	47, 400	1, 800	51, 500	2, 100	73, 700	2, 900
May	83, 200	3, 200	38, 400	1, 500	52, 200	1, 900	65, 500	2, 400
June	77, 300	3, 000	34, 800	1, 300	55, 500	2, 100	62, 700	2, 400
July	67, 200	2, 600	32, 800	1, 300	75, 800	3, 000	52, 200	2, 100
August	61, 600	2, 400	34, 800	1, 300	78, 600	2, 900	45, 400	1, 700
September	68, 900	2, 700	39, 400	1, 500	66, 800	2, 600	57, 100	2, 300
October	93, 400	3, 500	57, 000	2, 200	51, 000	2, 000	77, 800	2, 900
November	87, 100	3, 500	68, 400	2, 600	101, 900	3, 900	96, 800	3, 700
December	72, 600	2, 800	79, 400	3, 100	96, 900	3, 900	86, 800	3, 500
	1, 128, 300	3, 600	651, 900	2, 100	911, 100	2, 900	1, 028, 800	3, 300
Total coke:								
January	3, 227, 100	104, 700	2, 170, 900	70, 400	1, 871, 800	60, 900	2, 583, 000	83, 800
February	3, 033, 300	109, 200	2, 064, 600	71, 600	1, 727, 600	62, 300	2, 624, 200	94, 600
March	3, 378, 400	109, 800	2, 158, 600	69, 900	1, 763, 800	57, 300	3, 131, 800	101, 900
April	3, 233, 100	108, 300	1, 928, 600	64, 600	1, 703, 400	57, 200	2, 946, 200	98, 700
May	3, 199, 200	103, 700	1, 778, 600	57, 600	1, 967, 100	63, 600	3, 254, 300	105, 300
June	2, 784, 200	93, 200	1, 569, 900	52, 500	2, 292, 100	76, 700	3, 049, 700	102, 000
July	2, 628, 100	85, 200	1, 553, 800	50, 300	2, 869, 000	93, 100	2, 432, 000	78, 900
August	2, 497, 000	81, 000	1, 507, 100	48, 800	2, 998, 800	97, 100	2, 323, 100	75, 200
September	2, 372, 000	79, 500	1, 581, 800	52, 900	2, 774, 700	92, 900	2, 228, 400	74, 700
October	2, 475, 200	80, 300	1, 793, 100	58, 200	2, 630, 000	85, 200	2, 390, 200	77, 500
November	2, 356, 500	79, 100	1, 817, 400	60, 900	2, 443, 000	81, 900	2, 358, 300	79, 100
December	2, 299, 800	74, 600	1, 864, 300	60, 700	2, 547, 900	82, 900	2, 500, 400	81, 400
	33, 483, 900	92, 200	21, 788, 700	59, 900	27, 589, 200	76, 000	31, 821, 600	87, 700

[1] Figures for beehive coke and for total coke revised since last report.

TABLE 5.—*Coke shipped from the Connellsville and Lower Connellsville districts, Pennsylvania, 1930–34, by months, in net tons* [1]

Month	1930	1931	1932	1933	1934
January	124, 552	88, 110	43, 600	46, 900	56, 000
February	132, 627	84, 620	38, 300	47, 600	58, 800
March	130, 354	70, 820	33, 600	51, 300	70, 600
April	137, 546	41, 773	19, 900	29, 800	34, 500
May	130, 987	35, 937	15, 200	27, 200	19, 700
June	127, 252	33, 760	10, 500	32, 300	14, 500
July	95, 807	33, 487	10, 800	39, 800	11, 400
August	82, 847	32, 056	13, 400	30, 200	12, 200
September	78, 431	32, 227	14, 900	14, 800	25, 200
October	80, 304	43, 870	26, 100	8, 900	43, 000
November	67, 061	44, 413	35, 600	51, 400	46, 700
December	70, 082	35, 890	41, 100	56, 200	46, 100
	1, 257, 850	[2] 576, 963	303, 000	436, 400	438, 700

[1] From the Connellsville Courier. The weekly shipments as reported by the Courier have been prorated on a monthly basis by the Bureau of Mines.
[2] Total revised to 573,730. The Daily Courier, Jan. 12, 1933.

TABLE 6.—*Beehive coke produced in the United States in 1934, by weeks*

[Estimated from railroad shipments]

Week ended—	Net tons	Week ended—	Net tons	Week ended—	Net tons
Jan. 6	22,900	May 12	14,700	Sept. 15	14,900
Jan. 13	22,200	May 19	14,800	Sept. 22	14,600
Jan. 20	26,800	May 26	13,500	Sept. 29	13,900
Jan. 27	26,700	June 2	14,500	Oct. 6	15,000
Feb. 3	25,900	June 9	16,000	Oct. 13	15,800
Feb. 10	27,300	June 16	14,600	Oct. 20	18,100
Feb. 17	35,100	June 23	12,600	Oct. 27	18,600
Feb. 24	37,500	June 30	15,100	Nov. 3	21,900
Mar. 3	41,300	July 7	11,300	Nov. 10	22,200
Mar. 10	40,900	July 14	13,700	Nov. 17	24,400
Mar. 17	40,200	July 21	12,400	Nov. 24	24,000
Mar. 24	34,800	July 28	11,600	Dec. 1	18,900
Mar. 31	30,400	Aug. 4	10,500	Dec. 8	21,800
Apr. 7	21,000	Aug. 11	9,000	Dec. 15	16,500
Apr. 14	17,900	Aug. 18	9,100	Dec. 22	24,500
Apr. 21	15,900	Aug. 25	10,500	Dec. 29	18,000
Apr. 28	16,800	Sept. 1	11,500		
May 5	15,400	Sept. 8	11,300	Total	1,028,800

TABLE 7.—*Byproduct coke produced in the United States in 1934, by months and by States, in net tons*

[Based on reports from all producers]

State	Jan.	Feb.	Mar.	Apr.	May	June	July
Alabama	216,100	210,500	226,300	161,000	194,600	200,200	181,100
Colorado	15,100	12,300	12,800	13,600	14,100	13,400	13,700
Illinois	136,600	130,200	144,300	126,100	132,500	129,600	128,200
Indiana	173,000	187,400	260,100	256,400	321,300	295,700	213,100
Maryland	61,500	66,100	93,400	91,400	93,800	77,700	52,700
Massachusetts	93,900	88,400	93,900	92,000	94,100	84,700	81,300
Michigan	195,700	184,200	206,300	200,600	216,700	222,000	222,600
Minnesota	39,700	36,100	36,900	34,200	35,300	31,700	29,600
New Jersey	73,700	69,800	78,400	75,100	78,500	75,500	78,200
New York	340,600	343,500	379,800	373,400	375,300	354,800	318,800
Ohio	356,300	405,000	471,800	447,800	484,500	440,500	321,900
Pennsylvania	529,400	517,400	667,700	720,300	846,400	765,400	464,100
Tennessee	6,100	6,300	6,900	5,500	5,800	5,700	5,600
Utah	7,300	6,200	8,500	10,000	11,900	10,100	10,000
Washington	1,700	1,900	2,400	2,300	2,300	2,200	2,700
West Virginia	96,700	99,900	128,400	125,000	125,300	126,500	111,800
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	128,400	125,600	147,700	137,800	156,400	151,300	144,400
Total	2,471,800	2,490,800	2,965,600	2,872,500	3,188,800	2,987,000	2,379,800
At merchant plants	934,900	907,800	1,020,500	948,900	986,500	954,200	946,900
At furnace plants	1,536,900	1,583,000	1,945,100	1,923,600	2,202,300	2,032,800	1,432,900

State	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Alabama	154,300	144,600	158,300	130,100	132,100	2,109,200
Colorado	20,300	18,300	13,600	13,700	10,200	171,100
Illinois	131,400	136,700	151,000	149,600	153,700	1,649,900
Indiana	200,300	175,900	170,900	161,900	197,400	2,613,400
Maryland	44,600	35,500	59,900	48,800	59,100	784,500
Massachusetts	81,900	89,200	104,000	116,800	107,400	1,127,600
Michigan	226,900	216,000	218,000	214,300	224,500	2,547,800
Minnesota	31,900	34,400	35,900	34,800	37,000	417,500
New Jersey	78,400	75,100	77,300	73,500	76,600	910,100
New York	310,700	311,000	330,800	322,100	328,900	4,089,700
Ohio	261,400	239,000	258,300	278,800	331,000	4,296,300
Pennsylvania	471,200	453,500	473,900	450,900	474,200	6,834,400
Tennessee	5,400	5,200	5,600	5,900	6,600	70,600
Utah	10,600	10,500	10,700	10,400	11,200	117,400
Washington	2,300	2,500	2,400	2,500	2,000	27,200
West Virginia	106,100	90,900	100,100	108,500	124,700	1,343,900
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	140,000	133,000	141,700	138,900	137,000	1,682,200
Total	2,277,700	2,171,300	2,312,400	2,261,500	2,413,600	30,792,800
At merchant plants	934,000	929,300	993,500	992,100	1,002,400	11,551,000
At furnace plants	1,343,700	1,242,000	1,318,900	1,269,400	1,411,200	19,241,800

TABLE 8.—*Beehive coke produced in the United States in 1934, by months and by States, in net tons*

[Based on railroad shipments]

State	Jan.	Feb.	Mar.	Apr.	May	June	July
Colorado	2, 600	2, 300	3, 600	3, 100	3, 000	3, 100	2, 400
Pennsylvania	80, 600	102, 600	129, 400	42, 300	33, 100	33, 700	30, 500
Tennessee	200	200	1, 000	500	400	800	600
Utah	1, 600	1, 600	1, 300	1, 000	1, 100	1, 100	1, 100
Virginia	8, 000	10, 300	11, 000	7, 200	6, 000	5, 400	4, 900
Washington					200	200	300
West Virginia	18, 200	16, 400	19, 900	19, 600	21, 700	18, 400	12, 400
Total	111, 200	133, 400	166, 200	73, 700	65, 500	62, 700	52, 200

State	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Colorado	2, 500	3, 200	4, 000	3, 800	4, 200	37, 800
Pennsylvania	29, 300	42, 600	60, 000	73, 500	63, 000	720, 600
Tennessee	100	300	800	900	200	6, 000
Utah	500	800	1, 500	700	900	13, 200
Virginia	4, 600	4, 000	5, 000	5, 500	6, 100	78, 000
Washington	100	500		100	300	1, 700
West Virginia	8, 300	5, 700	6, 500	12, 300	12, 100	171, 500
Total	45, 400	57, 100	77, 800	96, 800	86, 800	1, 028, 800

PRODUCTION BY FURNACE AND NONFURNACE PLANTS

TABLE 9.—*Number and production of byproduct coke plants connected with iron furnaces and of other byproduct plants, 1913, 1918, and 1932–34*

Year	Number of active plants		Coke produced (net tons)		Percent of production	
	Furnace plants	Other plants	Furnace plants	Other plants	Furnace plants	Other plants
1913	20	16	9, 277, 832	3, 436, 868	73. 0	27. 0
1918	36	24	19, 220, 342	6, 777, 238	73. 9	26. 1
1932	44	44	11, 374, 371	9, 762, 471	53. 8	46. 2
1933	42	43	16, 144, 168	10, 533, 968	60. 5	39. 5
1934	41	42	19, 241, 850	11, 550, 961	62. 5	37. 5

TABLE 10.—*Monthly and average daily production of byproduct coke by plants associated with iron furnaces and by all other plants, 1932–34, in net tons*

Month	1932		1933		1934	
	Furnace plants	Other plants	Furnace plants	Other plants	Furnace plants	Other plants
Monthly production:						
January	1, 210, 000	887, 200	896, 800	885, 900	1, 536, 900	934, 900
February	1, 185, 100	807, 200	845, 100	791, 500	1, 583, 000	907, 800
March	1, 253, 700	831, 400	825, 200	837, 800	1, 945, 100	1, 020, 500
April	1, 090, 700	790, 500	853, 300	798, 600	1, 923, 600	948, 900
May	952, 700	787, 500	1, 082, 400	832, 500	2, 202, 300	986, 500
June	786, 100	749, 000	1, 426, 500	810, 100	2, 032, 800	954, 200
July	751, 300	769, 700	1, 957, 200	835, 900	1, 432, 900	946, 900
August	707, 700	764, 600	2, 018, 300	901, 900	1, 343, 700	934, 000
September	764, 800	777, 600	1, 776, 500	931, 400	1, 242, 000	929, 300
October	877, 000	859, 100	1, 591, 500	987, 500	1 318, 900	993, 500
November	903, 500	845, 500	1, 377, 800	963, 300	1, 269, 400	992, 100
December	891, 700	893, 200	1, 493, 400	957, 600	1, 411, 200	1, 002, 400
	11, 374, 300	9, 762, 500	16, 144, 100	10, 534, 000	19, 241, 800	11, 551, 000
Average daily production:						
January	39, 000	28, 600	28, 900	28, 600	49, 600	30, 100
February	40, 900	27, 800	30, 200	28, 300	56, 600	32, 400
March	40, 400	26, 800	26, 600	27, 000	62, 800	32, 900
April	36, 400	26, 400	28, 500	26, 600	64, 100	31, 700
May	30, 700	25, 400	34, 900	26, 800	71, 100	31, 800
June	26, 200	25, 000	47, 600	27, 000	67, 800	31, 800
July	24, 200	24, 800	63, 100	27, 000	46, 200	30, 600
August	22, 800	24, 700	65, 100	29, 100	43, 400	30, 100
September	25, 500	25, 900	59, 200	31, 100	41, 400	31, 000
October	28, 300	27, 700	51, 300	31, 900	42, 500	32, 100
November	30, 100	28, 200	45, 900	32, 100	42, 300	33, 100
December	28, 800	28, 800	48, 100	30, 900	45, 500	32, 400
Average	31, 100	26, 700	44, 200	28, 900	52, 700	31, 700

PRODUCTION BY STATES AND DISTRICTS

TABLE 11.—*Byproduct and beehive coke produced, by States, 1918 and 1931–34, in net tons*

State	1918	1931	1932	1933	1934
Byproduct:					
Alabama	2,634,451	2,943,143	1,400,597	1,668,975	2,109,192
Colorado	230,663	225,760	92,384	139,722	171,104
Connecticut		(1)	(1)	(1)	(1)
Illinois	2,285,610	2,478,984	1,428,334	1,501,020	1,649,907
Indiana	3,898,215	2,757,135	1,435,405	2,089,100	2,613,437
Kentucky	517,749	(1)	(1)	(1)	(1)
Maryland	474,268	817,995	499,502	702,227	784,539
Massachusetts	556,397	1,150,270	987,106	1,020,255	1,127,632
Michigan	(1)	2,436,630	2,165,109	2,341,081	2,547,747
Minnesota	784,065	440,489	385,699	412,037	417,447
Missouri	(1)	(1)	(1)	(1)	(1)
New Jersey	682,148	930,912	805,720	835,125	910,121
New York	1,069,587	3,578,311	3,130,078	3,426,529	4,089,708
Ohio	5,226,334	3,932,939	2,346,686	3,676,727	4,296,338
Pennsylvania	4,586,981	7,524,722	4,037,810	6,170,240	6,834,362
Rhode Island		(1)	(1)	(1)	(1)
Tennessee	124,469	83,439	72,529	71,484	70,598
Utah		146,788	103,862	66,945	117,401
Washington	30,129	30,104	32,610	31,817	27,199
West Virginia	603,393	1,265,039	902,872	1,074,002	1,343,914
Wisconsin	(1)	(1)	(1)	(1)	(1)
Combined States	2,293,021	1,612,889	1,310,539	1,450,850	1,682,165
	25,997,580	32,355,549	21,136,842	26,678,136	30,792,811
Beehive:					
Alabama	1,717,721				
Colorado	758,784	(1)	23,560	35,161	37,804
Georgia	22,048				
Kentucky	301,036				
New Mexico	597,072				
Ohio	138,909				
Oklahoma	(1)				
Pennsylvania	22,136,664	855,527	506,377	670,179	720,593
Tennessee	302,637	17,074	10,954	[2] 11,807	5,993
Utah	(1)	(1)	5,511	10,156	13,203
Virginia	1,234,256	99,305	56,143	70,493	77,960
Washington	93,659	582	736	379	1,694
West Virginia	2,716,613	113,627	48,607	[2] 112,883	171,518
Combined States	461,393	42,222			
	30,480,792	1,128,337	651,888	[2] 911,058	1,028,765
Grand total	56,478,372	33,483,886	21,788,730	[2] 27,589,194	31,821,576

[1] Included under "Combined States." [2] Revised since last report.

TABLE 12.—*Byproduct and beehive coke produced in Pennsylvania in 1934, by districts*

[Number of plants and ovens includes those idle during the year; no new ovens were under construction in 1934]

District	Plants	Ovens	Coal used (net tons)	Yield of coke from coal (percent)	Coke produced (net tons)	Value of coke at ovens	
						Total	Per ton
Byproduct:							
Eastern Pennsylvania [1]	5	774	2,370,717	69.31	1,643,188	$9,424,916	$5.74
Western Pennsylvania [2]	7	2,614	7,712,497	67.31	5,191,174	18,178,386	3.50
	12	3,388	10,083,214	67.78	6,834,362	27,603,302	4.04
Beehive:							
Allegheny Mountain and Allegheny Valley	3	434	50,829	63.20	32,126	134,042	4.17
Connellsville	17	4,305	165,059	66.21	109,285	423,091	3.87
Lower Connellsville	19	2,840	519,955	64.20	333,821	1,059,105	3.17
Upper Connellsville	5	580	184,042	64.11	117,992	428,464	3.63
Pittsburgh [3] and other districts [4]	5	1,257	204,591	62.26	127,369	510,111	4.00
	49	[5] 9,416	1,124,476	64.08	720,593	2,554,813	3.55
Grand total	61	12,804	11,207,690	67.41	7,554,955	30,158,115	3.99

[1] Includes plants at Bethlehem, Chester, Philadelphia, Steelton, and Swedeland.
[2] Includes plants at Aliquippa, Clairton, Erie, Johnstown, Midland, Neville Island, and Pittsburgh.
[3] There was no production in the Pittsburgh district during 1934.
[4] Includes Bedford and parts of Indiana and Westmoreland Counties.
[5] Includes 131 old ovens repaired and put into operation.

TABLE 13.—*Byproduct coke produced in Ohio in 1934, by districts*

District	Plants	Ovens	Coal used (net tons)	Yield of coke from coal (percent)	Coke produced (net tons)	Value of coke at ovens	
						Total	Per ton
Canton, Cleveland, and Massillon	5	595	1,617,070	69.44	1,122,924	$4,638,085	$4.13
Youngstown	3	594	1,474,046	68.48	1,009,369	4,385,725	4.35
Other districts [1]	7	645	3,009,833	71.90	2,164,045	9,978,085	4.61
Total	15	1,834	6,100,949	70.42	4,296,338	19,001,895	4.42

[1] Includes plants at Hamilton, Ironton, Lorain, Painesville, Portsmouth, Toledo, and Warren.

NUMBER AND TYPE OF OVENS

TABLE 14.—*Coke ovens completed and abandoned in 1934 and total number in existence at end of year, by States*

State	Plants in existence Dec. 31	Ovens [1]—		
		Abandoned during year	In existence Dec. 31	
			Number	Capacity per day (net tons of coke)
Byproduct:				
Alabama	8		1,248	14,110
Colorado	1		151	2,233
Connecticut	1		61	(2)
Illinois	8		950	13,382
Indiana	6		1,550	21,506
Kentucky	1		108	(2)
Maryland	1		361	5,088
Massachusetts	3		430	4,483
Michigan	9		674	7,882
Minnesota	3		196	2,562
Missouri	1		64	(2)
New Jersey	2		202	2,480
New York	9		1,024	15,020
Ohio	15		1,834	25,167
Pennsylvania	12	90	3,388	45,977
Rhode Island	1		65	(2)
Tennessee	1		24	360
Utah	1		56	1,015
Washington	1		20	101
West Virginia	4		362	4,905
Wisconsin	2		195	(2)
Undistributed				5,666
Total byproduct	90	90	[3] 12,963	171,937
At merchant plants	44		3,607	42,719
At furnace plants	46	90	9,356	129,218
Beehive:				
Colorado	2		378	(4)
Oklahoma	1		100	(4)
Pennsylvania	49	2,115	9,416	(4)
Tennessee	3	1	429	(4)
Utah	1		819	(4)
Virginia	7	300	1,299	(4)
Washington	1	22	58	(4)
West Virginia	11	403	1,707	(4)
Total beehive	75	2,841	[5] 14,206	(4)

[1] No new ovens were put into operation during the year, and no new ovens were under construction at the end of 1934. There were, however, 138 byproduct ovens, construction on which was completed in 1931, which were put into operation for the first time during 1934.
[2] Included under "Undistributed."
[3] Includes 82 ovens, with a capacity of 1,244 tons per day, completed but not put into operation.
[4] Data not available.
[5] Includes 199 old ovens, repaired or rebuilt and put into operation.

TABLE 15.—*Byproduct ovens of each type at end of 1934, by States*

State	Koppers[1]	Semet-Solvay	Wilputte	United Otto	Cambria-Belgian	Roberts[2]	American Foundation	Klönne	All others[3]	Total
Alabama	768	420	60							1,248
Colorado	151									151
Connecticut	61									61
Illinois	662	120	88			80				950
Indiana	1,269	161	120							1,550
Kentucky		108								108
Maryland	361									361
Massachusetts	175		55	200						430
Michigan	131	336	120						87	674
Minnesota	196									196
Missouri	56								8	64
New Jersey	202									202
New York	743	226					55			1,024
Ohio	1,541	293								1,834
Pennsylvania	3,018	128	97		120	25				3,388
Rhode Island	65									65
Tennessee		24								24
Utah	56									56
Washington								20		20
West Virginia	316		46							362
Wisconsin	115	80								195
Total	9,886	1,896	586	200	120	105	55	20	95	12,963
At merchant plants	1,911	1,080	221	200		25	55	20	95	3,607
At furnace plants	7,975	816	365		120	80				9,356

[1] Includes the Koppers-Becker type.
[2] Includes the Robert-Morrissey type.
[3] Includes 8 Piette, 27 Parker-Russell, and 60 improved Equipment Co. ovens.

CAPACITY OF BYPRODUCT OVENS

TABLE 16.—*Estimated annual potential production of coke and coal required for charge of byproduct coke ovens in the United States, 1932–34, when operated at different percentages of maximum capacity, in millions of net tons*

Percent of maximum capacity	Ovens completed Dec. 31[1]					
	1932		1933		1934	
	Coke	Coal[2]	Coke	Coal[2]	Coke	Coal[2]
100	62.8	89.7	63.1	90.1	62.8	89.7
90	56.5	80.7	56.8	81.1	56.5	80.7
85	53.4	76.2	53.6	76.6	53.4	76.2
75	47.1	67.3	47.3	67.6	47.1	67.3
50	31.4	44.9	31.6	45.1	31.4	44.9

[1] No ovens under construction at end of 1932, 1933, or 1934.
[2] Coal for charge estimated on basis of 70-percent yield in coke.

TABLE 17.—*Relation (percent) of production to maximum capacity at byproduct coke plants, 1929–34, by months*

Month	1929	1930	1931	1932	1933	1934	Month	1929	1930	1931	1932	1933	1934
January	88.6	82.8	59.2	39.0	33.6	46.6	August	93.6	69.2	46.8	27.4	55.0	42.8
February	91.3	87.5	61.5	39.6	34.1	52.0	September	91.9	66.7	45.7	29.7	52.7	42.1
March	93.0	86.6	62.4	38.8	31.3	55.9	October	92.3	64.9	45.8	32.3	48.6	43.5
April	92.8	85.7	62.3	36.2	32.2	56.0	November	89.0	60.5	45.0	33.6	45.6	43.9
May	94.0	82.7	59.9	32.4	36.1	60.1	December	83.1	57.5	42.7	33.2	46.2	45.3
June	93.9	79.2	53.7	29.5	43.5	58.2							
July	93.0	72.3	49.2	28.3	52.6	44.7	The year	91.4	73.5	52.8	33.6	42.7	49.2

QUANTITY AND COST OF COAL CHARGED

TABLE 18.—*Coal consumed in coke ovens, 1932–34, by months, in net tons*

[For figures, 1912–30, inclusive, see Coke and Byproducts in 1928, pp. 731–733, and Coke and Byproducts in 1930, p. 514]

Month	1932			1933			1934		
	Byproduct	Beehive	Total	Byproduct	Beehive[1]	Total[1]	Byproduct	Beehive	Total
January	3, 065, 300	116, 400	3, 181, 700	2, 580, 000	144, 300	2, 724, 300	3, 574, 000	177, 000	3, 751, 000
February	2, 913, 500	114, 100	3, 027, 600	2, 370, 700	148, 100	2, 518, 800	3, 597, 200	211, 800	3, 809, 000
March	3, 052, 500	116, 100	3, 168, 600	2, 407, 800	164, 400	2, 572, 200	4, 284, 700	264, 700	4, 549, 400
April	2, 749, 700	74, 900	2, 824, 600	2, 395, 000	82, 800	2, 477, 800	4, 155, 600	117, 400	4, 273, 000
May	2, 542, 700	60, 700	2, 603, 400	2, 780, 100	83, 300	2, 863, 400	4, 615, 100	103, 600	4, 718, 700
June	2, 241, 500	55, 000	2, 296, 500	3, 250, 400	88, 200	3, 338, 600	4, 321, 500	100, 300	4, 421, 800
July	2, 219, 300	51, 800	2, 271, 100	4, 057, 100	120, 500	4, 177, 600	3, 403, 100	83, 200	3, 486, 300
August	2, 147, 200	55, 000	2, 202, 200	4, 234, 800	124, 400	4, 359, 200	3, 262, 400	71, 700	3, 334, 100
September	2, 254, 400	62, 200	2, 316, 600	3, 926, 400	104, 800	4, 031, 200	3, 112, 300	89, 900	3, 202, 200
October	2, 537, 800	90, 000	2, 627, 800	3, 734, 200	79, 300	3, 813, 500	3, 315, 400	124, 500	3, 439, 900
November	2, 556, 500	108, 000	2, 664, 500	3, 390, 600	163, 500	3, 554, 100	3, 244, 400	154, 300	3, 398, 700
December	2, 606, 800	125, 400	2, 732, 200	3, 553, 800	157, 700	3, 711, 500	3, 457, 300	136, 900	3, 594, 200
	30, 887, 200	1, 029, 600	31, 916, 800	38, 680, 900	1, 461, 300	40, 142, 200	44, 343, 000	1, 635, 300	45, 978, 300

[1] Revised since last report.

TABLE 19.—*Total quantity and value at ovens of coal used in manufacture of coke, by States, in 1934*

State	Coal used (net tons)	Cost of coal		Coal per ton of coke	
		Total	Per ton of coal	Net tons	Cost
Byproduct plants:					
Alabama	3, 024, 628	$6, 897, 570	$2. 28	1. 43	$3. 26
Colorado	258, 428	(1)	(1)	1. 51	--------
Illinois	2, 445, 816	10, 981, 478	4. 49	1. 48	6. 65
Indiana	3, 659, 071	16, 392, 205	4. 48	1. 40	6. 27
Maryland	1, 100, 271	(1)	(1)	1. 40	--------
Massachusetts	1, 583, 523	7, 623, 211	4. 81	1. 40	6. 73
Michigan	3, 610, 917	14, 895, 382	4. 13	1. 42	5. 86
Minnesota	609, 738	(1)	(1)	1. 46	--------
New Jersey	1, 294, 829	(1)	(1)	1. 42	--------
New York	5, 862, 685	25, 476, 100	4. 35	1. 43	6. 22
Ohio	6, 100, 949	21, 310, 480	3. 49	1. 42	4. 96
Pennsylvania	10, 083, 214	30, 624, 499	3. 04	1. 48	4. 50
Tennessee	100, 984	321, 344	3. 18	1. 43	4. 55
Utah	194, 161	(1)	(1)	1. 65	--------
Washington	50, 030	229, 954	4. 60	1. 84	8. 46
West Virginia	1, 982, 557	4, 107, 257	2. 07	1. 48	3. 06
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	2, 381, 197	10, 285, 302	4. 32	1. 42	6. 13
Undistributed	------------	15, 054, 803	4. 35	--------	--------
Total byproduct	44, 342, 998	164, 199, 585	3. 70	1. 44	5. 33
At merchant plants	16, 464, 041	72, 016, 906	4. 37	1. 43	6. 25
At furnace plants	27, 878, 957	92, 182, 679	3. 31	1. 45	4. 80
Beehive plants:					
Colorado and Utah	83, 164	223, 642	2. 69	1. 63	4. 38
Pennsylvania	1, 124, 476	1, 809, 490	1. 61	1. 56	2. 51
Tennessee	12, 502	17, 830	1. 43	2. 09	2. 99
Virginia	131, 275	233, 080	1. 78	1. 68	2. 99
Washington	2, 686	10, 742	4. 00	1. 59	6. 36
West Virginia	281, 191	420, 203	1. 49	1. 64	2. 44
Total beehive	1, 635, 294	2, 714, 987	1. 66	1. 59	2. 64

[1] Included under "Undistributed."

TABLE 20.—*Average cost per net ton of coal charged into byproduct coke ovens, by States, 1929 and 1931–34*

State	1929	1931	1932	1933	1934	State	1929	1931	1932	1933	1934
Alabama	$2.49	$2.19	$1.95	$1.81	$2.28	Pennsylvania	$2.73	$2.77	$2.86	$2.84	$3.04
Illinois	4.29	4.33	4.17	4.02	4.49	Tenneesse	3.02	2.97	2.96	2.92	3.18
Indiana	4.61	4.42	4.25	4.19	4.48	Washington	5.26	5.12	4.61	4.51	4.60
Massachusetts	4.70	4.65	4.49	4.34	4.81	West Virginia	2.41	1.98	1.76	1.78	2.07
Michigan	4.29	4.22	3.92	3.67	4.13						
Minnesota	5.04	5.19	5.14	4.69	(1)	United States average	3.50	3.55	3.55	3.38	3.70
New York	4.22	4.26	4.17	4.00	4.35	Cost of coal per ton of coke	5.04	5.15	5.18	4.90	5.33
Ohio	3.31	3.40	3.20	3.10	3.49						

1 Not at liberty to publish data.

PREPARATION AND SOURCE OF COAL CHARGED

TABLE 21.—*Washed and unwashed coal used in the manufacture of byproduct and beehive coke, by States in which used, in 1934, in net tons*

State	Washed	Unwashed	Total
Byproduct ovens:			
Alabama	3,018,697	5,931	3,024,628
Colorado	258,428		258,428
Illinois	374,040	2,071,776	2,445,816
Indiana		3,659,071	3,659,071
Maryland		1,100,271	1,100,271
Massachusetts	8,459	1,575,064	1,583,523
Michigan		3,610,917	3,610,917
Minnesota		609,738	609,738
New Jersey		1,294,829	1,294,829
New York	1,105,421	4,757,264	5,862,685
Ohio	629,978	5,470,971	6,100,949
Pennsylvania	3,889,828	6,193,386	10,083,214
Tennessee	100,984		100,984
Utah		194,161	194,161
Washington	50,030		50,030
West Virginia		1,982,557	1,982,557
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	28,389	2,352,808	2,381,197
Total	9,464,254	34,878,744	44,342,998
At merchant plants	1,661,274	14,802,767	16,464,041
At furnace plants	7,802,980	20,075,977	27,878,957
Beehive ovens:			
Colorado	58,011		58,011
Pennsylvania	333,681	790,795	1,124,476
Tennessee	12,502		12,502
Utah		25,153	25,153
Virginia		131,275	131,275
Washington	2,686		2,686
West Virginia		281,191	281,191
Total	406,880	1,228,414	1,635,294

TABLE 22.—*Coal used in manufacture of byproduct coke in 1934, by fields of origin, in net tons*

[Based upon detailed reports from each coke plant. The difference between these totals and those shown in tables 3, 19, etc., is due to change in stock, loss of weight in handling, and the fact that these sometimes represent purchases during the year rather than actual consumption]

State and district where coal was produced	Total used	States where coal was consumed—in order of importance
Alabama	2,967,236	Alabama.
Colorado:		
Trinidad	242,568	Colorado.
Canon, Crested Butte, and Walsen districts.	44,758	Do.
Kentucky:		
Eastern Kentucky:		
Elkhorn	1,598,297	Indiana, Michigan, Missouri, Illinois, New York, Minnesota, Ohio, and Kentucky.
Harlan	1,787,761	Indiana, Illinois, Michigan, Minnesota, Ohio, and New York.
Kenova-Thacker [1]	184,822	Wisconsin, Ohio, and Michigan.
Miscellaneous Eastern Kentucky	13,196	Indiana.
Southern Appalachian	300	Ohio.
Pennsylvania:		
Central Pennsylvania, medium and high volatile.	246,872	New York.
Central Pennsylvania, low volatile	717,020	Pennsylvania and New York.
Connellsville	7,139,888	Pennsylvania, Ohio, West Virginia, Illinois, and Indiana.
Freeport	1,128,589	West Virginia, New York, and Indiana.
Pittsburgh	7,490,732	Pennsylvania, New York, Michigan, Ohio, Minnesota, Illinois, Wisconsin, New Jersey, Massachusetts, and Indiana.
Somerset	497,960	Pennsylvania, Ohio, and West Virginia.
Westmoreland	702,695	Pennsylvania, Maryland, and New York.
Tennessee	75,032	Tennessee.
Utah: Carbon County	194,161	Utah.
Virginia:[2] Wise, Lee, and Dickenson Counties.	355,445	New Jersey, New York, and Massachusetts.
Washington: Pierce County	50,030	Washington.
West Virginia:[1]		
Northern	2,411,197	Pennsylvania, Ohio, Maryland, West Virginia, New Jersey, and Massachusetts.
Kanawha and Logan	7,572,204	Ohio, New York, Illinois, Massachusetts, Pennsylvania, Michigan, Indiana, New Jersey, Wisconsin, Connecticut, Rhode Island, West Virginia, Kentucky, Minnesota, and Missouri.
New River and Winding Gulf	2,347,421	Massachusetts, New Jersey, New York, Illinois, Rhode Island, Ohio, Connecticut, Michigan, Missouri, Minnesota, and Indiana.
Pocahontas [2]	6,880,863	Michigan, Indiana, Ohio, New York, Illinois, Maryland, Pennsylvania, Wisconsin, Kentucky, Connecticut, Minnesota, West Virginia, Alabama, and Tennessee.
Miscellaneous	19,149	Ohio and Illinois.
	44,668,196	

[1] Coal from the extension of the Thacker field in Mingo County, W. Va., and Buchanan County, Va., is included under Kentucky (Thacker).
[2] Coal from the extension of the Pocahontas field in Tazewell County, Va., is included under West Virginia (Pocahontas).

TABLE 23.—*Source of coal used in the manufacture of byproduct coke in 1934, by States where consumed, separating merchant and furnace plants*

State where coal was used	Coal produced in—									Total
	Alabama	Colorado	Kentucky	Pennsylvania	Tennessee	Utah	Virginia	Washington	West Virginia	
Alabama:										
Merchant plants	464,400								57,400	521,800
Furnace plants	2,502,836									2,502,836
Total	2,967,236								57,400	3,024,636
Colorado: Furnace plants		287,326								287,326
Illinois:										
Merchant plants			121,099	103,306					1,259,607	1,484,012
Furnace plants			429,079	289,414					243,312	961,805
Total			550,178	392,720					1,502,919	2,445,817
Indiana:										
Merchant plants									634,071	634,071
Furnace plants			1,472,672	149,348					1,402,980	3,025,000
Total			1,472,672	149,348					2,037,051	3,659,071
Maryland: Furnace plants				211,362					888,909	1,100,271
Massachusetts: Merchant plants				12,488			29,846		1,543,420	1,585,754
Michigan:										
Merchant plants			396,698	784,124					920,462	2,101,284
Furnace plants			266,799						1,522,382	1,789,181
Total			663,497	784,124					2,442,844	3,890,465
Minnesota:										
Merchant plants			94,232	142,444					186,681	423,357
Furnace plants			84,119	54,158					48,104	186,381
Total			178,351	196,602					234,785	609,738
New Jersey: Merchant plants				25,000			193,324		1,061,959	1,280,283
New York:										
Merchant plants			144,501	1,942,678			132,275		1,589,842	3,809,296
Furnace plants			27,385	1,549,437					478,855	2,055,677
Total			171,886	3,492,115			132,275		2,068,697	5,864,973

Ohio:										
Merchant plants			476				50,189		707,806	758,471
Furnace plants			141,350	2,777,225					2,393,989	5,312,564
Total			141,826	2,777,225			50,189		3,101,795	6,071,035
Pennsylvania:										
Merchant plants				73,710					770,231	843,941
Furnace plants				8,337,994					987,054	9,325,048
Total				8,411,704					1,757,285	10,168,989
Tennessee: Merchant plants					75,032				19,146	94,178
Utah: Furnace plants						194,161				194,161
Washington: Merchant plants								50,030		50,030
West Virginia:										
Merchant plants									535,705	535,705
Furnace plants				1,442,679					7,327	1,450,006
Total				1,442,679					543,032	1,985,711
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin: Merchant plants			355,227	28,389					1,972,142	2,355,758
Grand total	2,967,236	287,326	3,533,637	17,923,756	75,032	194,161	405,634	50,030	19,231,384	44,668,196
Merchant plants	464,400		1,112,233	3,112,139	75,032		405,634	50,030	11,258,472	16,477,940
Furnace plants	2,502,836	287,326	2,421,404	14,811,617		194,161			7,972,912	28,190,256

YIELD OF COKE PER TON OF COAL

TABLE 24.—*Percentage yield of coke from coal in byproduct and beehive ovens, by States, 1931–34*

State	1931		1932		1933		1934	
	Byproduct	Beehive	Byproduct	Beehive	Byproduct	Beehive	Byproduct	Beehive
Alabama	70.55		69.14		68.94		69.73	
Colorado	68.65	65.10	68.19	65.20	66.28	64.54	66.21	65.17
Illinois	68.02		66.05		66.93		67.46	
Indiana	70.89		69.28		70.93		71.42	
Maryland	73.78		73.22		72.25		71.30	
Massachusetts	71.73		70.17		68.80		71.21	
Michigan	70.55		70.03		69.97		70.56	
Minnesota	67.54		67.73		68.18		68.46	
New Jersey	70.80		69.21		70.26		70.29	
New York	69.67		69.56		69.06		69.76	
Ohio	67.95		68.26		70.33		70.42	
Pennsylvania	66.88	65.31	66.03	65.11	67.21	63.68	67.78	64.08
Tennessee	72.38	50.33	71.75	49.08	70.91	[1] 47.42	69.91	47.94
Utah	54.33	49.94	54.53	42.08	53.94	46.34	60.47	52.49
Virginia		60.32		58.80		58.22		59.39
Washington	54.01	60.82	56.54	61.03	56.00	60.93	54.37	63.07
West Virginia	69.44	59.56	67.35	58.13	67.96	[1] 60.77	67.79	61.00
United States average	69.07	63.86	68.43	63.31	68.97	[1] 62.35	69.44	62.90

[1] Revised since last report.

COKE BREEZE

TABLE 25.—*Coke breeze recovered at coke plants, by States, in 1934*

State	Yield per ton of coal (percent)	Produced		Used by producer: For steam raising		Used by producer: For other purposes, including water gas		Sold		Wasted (net tons)	On hand Dec. 31 (net tons)
		Net tons	Value	Net tons	Value	Net tons	Value	Net tons	Value		
Byproduct ovens:											
Alabama	4.38	132,403	$164,944	102,391	$121,161	5,423	$7,745	33,686	$41,316	1,784	21,364
Colorado	6.67	17,250	(1)	17,250	(1)						
Illinois	7.91	193,563	468,916	152,660	368,502			53,085	129,184		50,834
Indiana	5.61	205,197	531,035	114,305	268,882	41,650	84,537	47,050	171,382		9,424
Maryland	6.91	76,027	(1)	26,826	(1)	16,992	(1)	17,375	(1)		35,508
Massachusetts	8.14	128,980	240,583	16,312	32,987	1,621	4,312	107,495	197,363		4,975
Michigan	6.21	224,235	496,064	163,498	423,395	4,288	12,599	110,110	172,385		102,805
Minnesota	8.06	49,175	(1)	36,688	(1)			12,693	(1)		11,142
New Jersey	5.57	72,118	(1)	63,303	(1)			4,787	(1)		4,292
New York	5.93	347,525	906,061	138,672	343,569	91,203	307,551	91,661	221,065		72,920
Ohio	5.35	326,676	627,097	254,645	502,428	22,876	42,683	56,162	106,157	3,313	53,645
Pennsylvania	6.13	619,330	987,338	500,412	761,984	57,620	99,291	64,255	128,529		24,555
Tennessee	8,39	8,473	31,469	5,596	19,586			2,877	11,883		95
Utah	4.61	8,944	(1)	6,290	(1)	3,873	(1)	10,491	(1)		
Washington	11.65	5,828	16,901	5,828	16,901						1,423
West Virginia	5.35	106,134	129,331	87,024	107,492	7,905	11,727	8,060	6,403		17,655
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	8.77	208,783	606,873	135,296	365,388	16,753	83,765	56,180	150,489		27,810
Undistributed			484,524		316,012		36,883		105,414		
Grand total, 1934	6.16	2,730,641	5,691,136	1,826,996	3,648,287	270,204	691,093	675,967	1,441,570	5,097	438,447
At merchant plants	7.02	1,156,404	2,838,606	645,041	1,606,697	110,213	396,835	415,664	870,698	3,274	267,741
At furnace plants	5.65	1,574,237	2,852,530	1,181,955	2,041,590	159,991	294,258	260,303	570,872	1,823	170,706
Grand total, 1933	6.55	2,533,381	5,054,641	1,640,046	3,185,981	297,259	705,898	625,530	1,231,490	12,391	438,795
Change, 1934 percent	−6.0	+7.8	+12.6	+11.4	+14.5	−9.1	−2.1	+8.1	+17.1	−58.9	−.1
Beehive ovens:											
Colorado	[2] 1.47	853	(1)					853	(1)		
Pennsylvania	[2] 8.28	46,074	14,714			989	828	13,767	4,064	21,946	6,193
Utah	[2] 2.39	601	(1)					601	(1)		1,622
Virginia	[2] 1.94	1,267	4,262	16	54	151	507	1,100	3,701		190
West Virginia	[2] 1.50	1,345	3,875					1,105	3,184		10
Undistributed			1,977						1,977		
Grand total, 1934	[2] 6.31	50,140	24,828	16	54	1,140	1,335	17,426	12,926	[3] 21,946	8,015

[1] Included under "Undistributed."
[2] Yield computed by dividing the production of breeze at the few plants reporting by the quantity of coal charged at these plants.
[3] As reported; quantity produced but not used was undoubtedly greater. See Mineral Resources, 1922, pt. II, pp. 726–727.

CONSUMPTION OF COKE

TABLE 26.—*Quantity of coke consumed in manufacture of pig iron and for other purposes, 1913, 1918, and 1932–34, in net tons*

Year	Total production of coke	Imports	Exports	Net changes in stocks	Indicated United States consumption [1]	Consumed by iron furnaces [2]		Remainder consumed in other ways	
						Quantity	Percent	Quantity	Percent
1913	46,299,530	101,212	987,395	(3)	45,413,347	37,192,287	81.9	8,221,060	18.1
1918	56,478,372	30,168	1,687,824	(3)	54,820,716	45,703,594	83.4	9,117,122	16.6
1932	21,788,730	117,275	630,151	−900,854	22,176,708	8,627,488	38.9	13,549,220	61.1
1933 [4]	27,589,194	160,873	637,819	−659,595	27,771,843	13,024,556	46.9	14,747,287	53.1
1934	31,821,576	160,934	942,785	+733,343	30,306,382	16,183,070	53.4	14,123,312	46.6

[1] Production plus imports minus exports, plus or minus the decrease or increase, respectively, of the net changes in stocks.
[2] From Annual Report of American Iron and Steel Institute. Figures include coke consumed in the manufacture of ferro-alloys.
[3] Data not available.
[4] Revised since last report.

TABLE 27.—*Pounds of coke and of coking coal consumed per gross ton of pig iron made in the United States, 1913, 1918, and 1932–34*

Year	Pounds of coke per gross ton of pig iron and ferro-alloys [1]	Percent yield of coke from coal	Calculated pounds coking coal per gross ton of pig iron and ferro-alloys	Year	Pounds of coke per gross ton of pig iron and ferro-alloys [1]	Percent yield of coke from coal	Calculated pounds coking coal per gross ton of pig iron and ferro-alloys
1913	2,433.3	66.9	3,637.2	1933	1,975.6	68.7	2,875.7
1918	2,375.2	66.4	3,577.1	1934	2,025.3	69.2	2,926.7
1932	1,988.1	68.3	2,910.8				

[1] From Annual Statistical Report of American Iron and Steel Institute, 1934. The consumption per ton of pig iron only, excluding the furnaces making ferro-alloys, was 1,954.1 in 1932, 1,935.7 in 1933, and 1,989.3 in 1934.

FURNACE, FOUNDRY, AND OTHER COKE

TABLE 28.—*Byproduct coke produced and sold or used by producer, by States, in 1934*

[Exclusive of screenings or breeze]

State	Produced		Used by producer in blast furnace, etc.[1]		Sold									
					Furnace [2]		Foundry		Domestic use		Industrial and other use (including water gas) [3]		Total	
	Net tons	Value	Net tons	Value	Net tons	Value	Net tons	Value	Net tons	Value	Net tons	Value	Net tons	Value
Alabama	2,109,192	$6,508,933	1,489,468	$4,204,539	8,496	$36,535	256,176	$1,109,598	361,229	$1,148,657	18,553	$33,462	644,454	$2,328,252
Colorado	171,104	([4])	149,791	([4])	2,936	([4])	14,966	([4])	1,172	([4])			19,074	([4])
Illinois	1,649,907	9,071,800	425,371	2,304,652	391	1,681	94,678	734,492	1,025,128	5,423,135	57,545	296,087	1,177,742	6,455,395
Indiana	2,613,437	16,957,287	2,136,283	14,289,069	3,127	23,110	86,635	659,101	360,731	1,814,896	16,408	91,883	466,901	2,588,990
Maryland	784,539	([4])	685,877	([4])					66	([4])	99,017	([4])	99,083	([4])
Massachusetts	1,127,632	7,181,783	83,402	547,034	22,177	141,208	33,030	212,425	859,291	5,456,228	13,730	85,883	928,228	5,895,744
Michigan	2,547,747	14,348,536	429,260	2,222,206	([4])	([4])	825	6,097	1,750,359	10,103,367	([4])	([4])	2,111,292	12,071,690
Minnesota	417,447	([4])	242	([4])			167	([4])	390,380	([4])	([4])	([4])	393,696	([4])
New Jersey	910,121	([4])	77,940	([4])			23,819	([4])	536,781	([4])	262,333	([4])	822,933	([4])
New York	4,089,708	25,283,246	911,125	5,226,725	([4])	([4])	([4])	([4])	1,883,792	12,715,669	367,980	2,356,682	3,080,020	19,440,754
Ohio	4,296,338	19,001,895	2,955,710	13,101,598	150,303	572,833	198,564	1,141,495	733,143	3,046,915	215,547	920,803	1,297,557	5,682,046
Pennsylvania	6,834,362	27,603,302	4,839,374	17,599,670	660,952	2,885,941	97,112	705,267	847,055	4,728,515	230,098	1,137,726	1,835,217	9,457,449
Tennessee	70,598	375,581	10,019	36,023			15,215	102,835	31,993	182,590	8,473	27,997	55,681	313,422
Utah	117,401	([4])	75,333	([4])	34,015	([4])			5,184	([4])	2,617	([4])	41,816	([4])
Washington	27,199	163,194	16,372	98,232			800	4,800	9,666	57,996	300	1,800	10,766	64,596
West Virginia	1,343,914	3,581,129	925,743	2,337,091			([4])	([4])	294,780	771,693	([4])	([4])	346,733	993,914
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	1,682,165	10,968,166	101,825	569,619	81,880	417,565	188,575	1,440,029	1,083,364	7,026,907	160,253	991,088	1,514,072	9,875,589
Undistributed		14,500,678		4,737,103	1,056,175	5,688,737	66,654	757,769		6,798,377	120,629	2,826,411		9,518,444
Grand total, 1934	30,792,811	155,545,530	15,313,135	67,273,561	2,020,452	9,767,610	1,077,216	6,873,908	10,174,114	59,274,945	1,573,483	8,769,822	14,845,265	84,686,285
At merchant plants	11,550,961	70,968,519	1,256,184	7,218,409	626,033	3,538,691	742,073	5,134,091	7,238,296	44,946,775	1,214,376	7,227,112	9,820,778	60,846,669
At furnace plants	19,241,850	84,577,011	14,056,951	60,055,152	1,394,419	6,228,919	335,143	1,739,817	2,935,818	14,328,170	359,107	1,542,710	5,024,487	23,839,616
Grand total, 1933	26,678,136	120,312,324	13,442,827	54,392,428	1,227,565	4,457,428	833,633	4,452,635	10,215,360	52,280,220	1,550,268	7,845,197	13,826,826	69,035,480
Change, 1934 ......percent	+15.4	+293	+13.9	+23.7	+64.5	+119.1	+29.2	+54.4	−0.4	+13.4	+1.5	+11.8	+7.4	+22.7

[1] 1934 totals include 1,476,500 tons, valued at $8,124,608, used for other purposes than in blast furnaces.
[2] 1934 totals include 1,067,847 tons, valued at $4,775,553, sold to affiliated corporations, and 952,605 tons, valued at $4,992,057, reported as merchant sales.
[3] 1934 totals include 587,438 tons, valued at $3,492,164, sold for manufacture of water gas.
[4] Included under "Undistributed."

TABLE 29.—*Beehive coke produced and sold or used by producer, by States, in 1934*

[Exclusive of screenings or breeze]

State	Produced		Used by producer [1]		Sold			
					Furnace [2]		Foundry	
	Net tons	Value	Net tons	Value	Net tons	Value	Net tons	Value
Colorado and Utah	51,007	$342,414			47,937	$324,918	3,354	$19,458
Pennsylvania	720,593	2,554,813	563	$1,604	99,485	320,749	112,654	518,976
Tennessee	5,993	23,422			2,734	8,202	3,568	16,666
Virginia	77,960	324,063			166	467	20,528	98,283
Washington	1,694	14,898					1,084	10,116
West Virginia	171,518	620,534			20,273	72,142	43,735	191,794
Total, 1934	1,028,765	3,880,144	563	1,604	170,595	726,478	184,923	855,293
Total, 1933	911,058	2,638,733	253	514	151,923	547,738	171,252	559,634
Change, 1934 percent	+12.9	+47.0	+122.5	+212.1	+12.3	+32.6	+8.0	+52.8

State	Sold					
	Domestic use		Industrial and other use (including water gas)[3]		Total	
	Net tons	Value	Net tons	Value	Net tons	Value
Colorado and Utah					51,291	$344,376
Pennsylvania	332,527	$1,114,165	166,566	$568,399	711,232	2,522,289
Tennessee					6,302	24,868
Virginia	159	474	56,989	224,710	77,842	323,934
Washington	610	4,782			1,694	14,898
West Virginia	12,885	44,489	95,557	315,944	172,450	624,369
Total, 1934	346,181	1,163,910	319,112	1,109,053	1,020,811	3,854,734
Total, 1933	275,677	673,028	286,719	793,745	885,571	2,574,145
Change, 1934 percent	+25.6	+72.9	+11.3	+39.7	+15.3	+49.7

[1] No beehive coke was used by the producer in blast furnaces in 1934.
[2] Totals include 44,036 tons valued at $290,991 sold to affiliated corporations and 126,559 tons valued at $435,487 reported as merchant sales.
[3] Totals include 69,296 tons valued at $224,104 sold for manufacture of water gas.

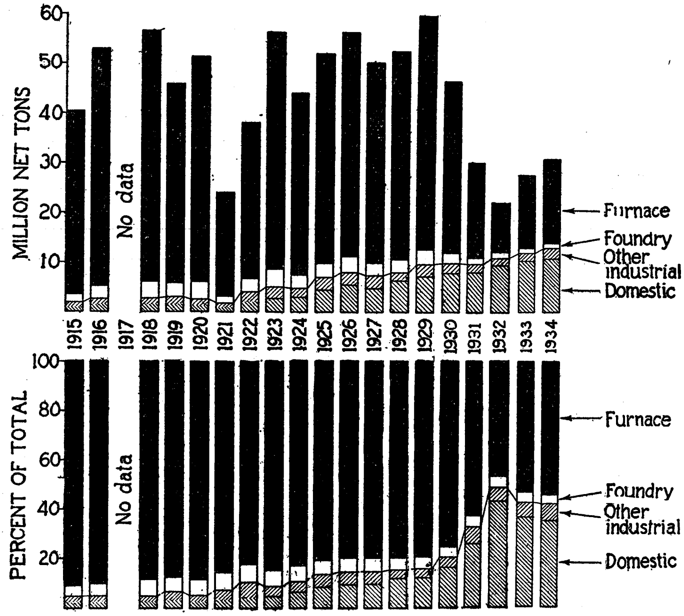

FIGURE 53.—Byproduct and beehive coke sold for furnace, foundry, other industrial, and domestic use, 1915–34. Figures for furnace coke include all coke used by the producer and not sold. The data represent the disposition made of the total production, including the exports, except that in 1915 and 1916 the exports are not included.

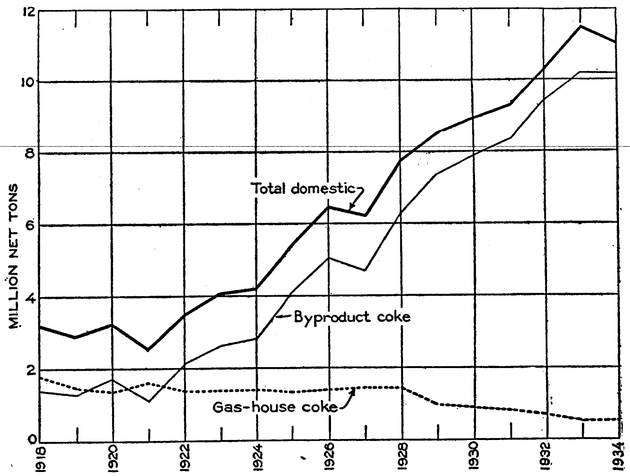

FIGURE 54.—Growth of sales of domestic coke, byproduct coke, and gas-house coke, 1918–34

DOMESTIC COKE

TABLE 30.—*Total supplies of fuels commonly used for domestic purposes in the United States, 1924 and 1931–34*

[Wherever available the figures represent the quantity actually consumed for domestic heating or for heating offices, apartments, hotels, schools, hospitals, etc. Where such figures are not available but where the fuel is known to be used chiefly for domestic purposes the total production (or imports) is shown in order to indicate the trend of growth. All figures represent latest revisions obtainable at time of publication. Figures for 1934 subject to revision]

	1924	1931	1932	1933	1934
Solid fuels (net tons)					
Pennsylvania anthracite production:					
Shipments of domestic sizes	56, 576, 296	35, 437, 946	29, 096, 962	27, 755, 333	32, 141, 000
Shipments of buckwheat no. 1 [1]	9, 510, 508	7, 956, 978	6, 735, 313	6, 625, 755	7, 672, 000
Shipments of smaller steam sizes	11, 160, 695	9, 240, 931	8, 029, 388	8, 954, 321	10, 369, 000
Local sales	3, 043, 939	2, 901, 117	2, 810, 337	3, 249, 552	3, 763, 000
Total commercial production	80, 291, 438	55, 536, 972	46, 672, 000	46, 584, 961	[2] 53, 945, 000
Anthracite exported	4, 017, 785	1, 778, 308	1, 303, 355	1, 034, 562	1, 297, 610
Anthracite imported, chiefly from United Kingdom and Russia	117, 951	637, 951	607, 097	456, 252	478, 118
Fuel briquets produced	580, 470	698, 316	470, 604	530, 430	704, 856
Fuel briquets imported	38	60, 950	80, 288	42, 395	----------
Byproduct coke sold for domestic use	2, 812, 771	8, 376, 652	9, 422, 343	10, 215, 360	10, 174, 114
Beehive coke sold for domestic use	139, 886	118, 665	207, 857	275, 677	346, 181
Coke imported	82, 833	103, 563	117, 275	160, 873	160, 934
Gas-house coke sold	[2] 1, 400, 000	[3] 813, 400	[2] 656, 000	[3] 498, 000	[2] 513, 200
Petroleum coke produced	761, 100	2, 032, 000	1, 789, 000	1, 580, 000	1, 300, 000
Anthracite and semianthracite produced outside of Pennsylvania	704, 513	507, 140	454, 028	350, 068	380, 055
Bituminous coal for domestic use	(4)	(4)	(4)	(4)	(4)
Oil (barrels)					
Domestic heating oils:					
Range oil [5]	(6)	4, 549, 000	6, 841, 000	9, 849, 000	(6)
Other light fuel oils	5, 021, 000	24, 848, 000	29, 264, 000	34, 140, 000	(6)
Commercial heating oils [7]	(6)	15, 731, 000	(6)	(6)	(6)
Liquified petroleum gases, domestic	(6)	364, 200	386, 800	395, 900	421, 000
Gas (million cubic feet)					
Natural gas consumed for domestic use [7]	285, 152	380, 897	385, 887	368, 774	(6)
Manufactured gas sold for domestic purposes	(6)	[3] 275, 318	[2] 246, 970	[3] 226, 557	[2] 233, 500

[1] A considerable part of the buckwheat no. 1 is used for domestic purposes.
[2] Partly estimated.
[3] Based on figures from Census of Manufactures.
[4] Between 56,000,000 and 77,000,000 tons a year.
[5] Oil used for heating houses.
[6] Data not available.
[7] Used for heating offices, hotels, apartments, schools, hospitals, and buildings other than houses.

STOCKS OF COKE

TABLE 31.—*Stocks of furnace, foundry, and domestic coke and of breeze on Jan. 1, 1935, by States, in net tons*

[Based on complete reports from all producers]

State	Furnace	Foundry	Domestic and other	Total coke	Breeze
Byproduct plants:					
Alabama	348,387	42,993	121,826	513,206	21,364
Colorado	3,998	323	674	4,995	
Illinois	24,795	443	429,455	454,693	50,834
Indiana	8,657	212	64,853	73,722	9,424
Maryland	11,899			11,899	35,508
Massachusetts	56	25	308,304	308,385	4,975
Michigan	2,234	428	119,330	121,992	102,805
Minnesota			115,207	115,207	11,142
New Jersey			146,058	146,058	4,292
New York	[1] 6,788	(1)	369,292	376,080	72,920
Ohio	66,872	1,674	133,197	201,743	53,645
Pennsylvania	338,401	3,678	339,591	681,670	24,555
Tennessee	33,897	102	25,983	59,982	95
Utah	2,761		3,445	6,206	
Washington		183	1,737	1,920	1,423
West Virginia	73,255	158	87,786	161,199	17,655
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	[1] 958	(1)	317,743	318,701	27,810
Total byproduct	[1] 922,958	[1] 50,219	2,584,481	3,557,658	438,447
At merchant plants	58,534	24,067	1,921,757	2,004,358	267,741
At furnace plants	863,574	27,002	662,724	1,553,300	170,706
Beehive plants:					
Colorado	91			91	
Pennsylvania	1,680	6,413	26,295	34,388	6,193
Tennessee		114		114	
Utah	225			225	1,622
Virginia	576	224	120	920	190
West Virginia	561	1,622	2,964	5,147	10
Total beehive	3,133	8,373	29,379	40,885	8,015

[1] A small amount of foundry coke is included with furnace.

TABLE 32.—*Summary of total stocks of coke on hand at all byproduct and beehive plants at first of year, 1929 and 1931–35*

	Jan. 1, 1929	Jan. 1, 1931	Jan. 1, 1932	Jan. 1, 1933	Jan. 1, 1934	Jan. 1, 1935
Byproduct plants:						
Furnace	750,318	1,106,996	1,376,902	1,360,660	919,583	922,108
Foundry	24,426	230,766	268,149	152,222	64,552	51,069
Domestic and other	1,018,205	1,916,526	2,734,219	1,985,380	1,835,743	2,584,481
	1,792,949	3,254,288	4,379,270	3,498,262	2,819,878	3,557,658
Beehive plants:						
Furnace	38,446	31,691	25,239	12,067	5,156	3,133
Foundry	8,020	6,061	8,513	7,138	10,979	8,373
Domestic and other	8,511	5,844	12,687	7,388	29,187	29,379
	54,977	43,596	46,439	26,593	45,322	40,885
Total:						
Furnace	788,764	1,138,687	1,402,141	1,372,727	924,739	925,241
Foundry	32,446	236,827	276,662	159,360	75,531	59,442
Domestic and other	1,026,716	1,922,370	2,746,906	1,992,768	1,864,930	2,613,860
	1,847,926	3,297,884	4,425,709	3,524,855	2,865,200	3,598,543

TABLE 33.—*Total stocks of coke on hand at all furnace and nonfurnace byproduct plants on first of each month, 1933 and 1934*

[Includes furnace, foundry, and domestic, but not breeze]

Date	Furnace plants		Other plants		Total	
	1933	1934	1933	1934	1933	1934
Jan. 1	1,626,074	1,354,618	1,872,188	1,465,260	3,498,262	2,819,878
Feb. 1	1,601,062	1,298,962	1,707,169	1,047,655	3,308,231	2,346,617
Mar. 1	1,482,514	1,120,558	1,348,734	687,244	2,831,248	1,807,802
Apr. 1	1,487,113	1,039,284	1,215,792	673,678	2,702,905	1,712,962
May 1	1,524,951	1,070,189	1,322,204	893,554	2,847,155	1,963,743
June 1	1,573,756	1,021,398	1,401,416	926,312	2,975,172	1,947,710
July 1	1,523,177	1,009,405	1,423,691	1,037,737	2,946,868	2,047,142
Aug. 1	1,464,155	1,068,999	1,487,051	1,242,651	2,951,206	2,311,650
Sept. 1	1,431,939	1,166,446	1,590,245	1,481,639	3,022,184	2,648,085
Oct. 1	1,432,195	1,254,590	1,647,428	1,591,327	3,079,623	2,845,917
Nov. 1	1,383,377	1,346,121	1,669,957	1,735,125	3,053,334	3,081,246
Dec. 1	1,376,845	1,405,409	1,665,986	2,012,494	3,042,831	3,417,903

VALUE AND PRICE

TABLE 34.—*Average receipts per net ton for coke sold, by States, in 1934*

State	Byproduct				Beehive			
	Furnace [1]	Foundry	Domestic	Other industrial, including water gas	Furnace [1]	Foundry	Domestic	Other industrial, including water gas
Alabama	$4.30	$4.33	$3.18	$1.80				
Colorado and Utah	6.77	4.05	3.13	5.12	$6.78	$5.80		
Illinois	4.30	7.76	5.29	5.15				
Indiana	7.39	7.61	5.03	5.60				
Maryland and New Jersey		7.70	6.86	6.04				
Massachusetts	6.37	6.43	6.35	6.26				
Michigan and Minnesota	(2)	7.56	6.17	(2)				
New York	(2)	(2)	6.75	6.40				
Ohio	3.81	5.75	4.16	4.27				
Pennsylvania	4.37	7.26	5.58	4.94	3.22	4.61	$3.35	$3.41
Tennessee		6.76	5.71	3.30	3.00	4.67		
Virginia					2.81	4.79	2.98	3.94
Washington		6.00	6.00	6.00		9.33	7.84	
West Virginia		(2)	2.62	(2)	3.56	4.39	3.45	3.31
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	5.10	7.64	6.49	6.18				
Undistributed	5.15	7.69		5.21				
Average	4.83	6.38	5.83	5.57	4.26	4.63	3.36	3.48
At merchant plants	5.65	6.92	6.21	5.95	(3)	(3)	(3)	(3)
At furnace plants	4.47	5.19	4.88	4.30	(3)	(3)	(3)	(3)

[1] Includes coke sold to affiliated corporations and merchant sales.
[2] Included under "Undistributed."
[3] Not available.

TABLE 35.—*Average monthly prices per net ton at ovens of spot or prompt Connellsville furnace and foundry coke, 1929 and 1931–34* [1]

Month	Furnace coke					Foundry coke				
	1929	1931	1932	1933	1934	1929	1931	1932	1933	1934
January	$2.75	$2.50	$2.25	$1.75	$3.60	$3.75	$3.50	$3.50	$2.50	$4.25
February	2.90	2.50	2.25	1.75	3.50	3.75	3.50	3.50	2.50	4.25
March	2.98	2.50	2.25	1.75	3.50	3.75	3.50	3.50	2.50	4.25
April	2.78	2.50	2.25	1.75	3.85	3.75	3.50	3.50	2.50	4.60
May	2.75	2.45	2.20	1.75	3.85	3.75	3.50	3.10	2.50	4.60
June	2.75	2.40	2.00	1.81	3.85	3.75	3.50	3.00	2.56	4.60
July	2.75	2.40	2.00	2.31	3.85	3.75	3.50	3.00	2.94	4.60
August	2.73	2.40	2.00	2.55	3.85	3.75	3.50	2.90	3.15	4.60
September	2.65	2.40	2.00	2.50	3.85	3.75	3.50	2.75	3.25	4.60
October	2.65	2.40	1.81	3.50	3.85	3.75	3.50	2.75	4.05	4.60
November	2.65	2.40	1.75	3.75	3.85	3.75	3.50	2.75	4.25	4.60
December	2.64	2.34	1.75	3.75	3.85	3.75	3.25	2.69	4.25	4.60
Average	2.75	2.43	2.04	2.41	3.77	3.75	3.48	3.08	3.08	4.51

[1] Iron Age, Jan. 3, 1935.

TABLE 36.—*Average monthly prices of byproduct foundry coke, in 11 markets, as quoted by Steel*

	January	February	March	April	May	June	July	August	September	October	November	December	Average for year
Ashland, Ky. (at ovens):[1]													
1932	$5.50	$5.50	$5.50	$5.50	$5.50	$5.00	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$4.96
1933	4.50	4.50	4.50	4.50	4.50	4.50	4.80	5.00	5.50	5.50	5.50	5.60	4.91
1934	6.00	6.00	[2]6.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Birmingham, Ala. (at ovens):													
1932	4.50	4.50	4.50	4.50	4.50	4.50	4.25	4.50	4.50	4.50	4.15	4.00	4.41
1933	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.40	4.50	4.75	4.85	4.85	4.28
1934	5.00	5.00	5.00	5.40	5.50	5.70	6.00	6.00	6.00	6.00	6.00	6.00	5.63
Buffalo, N. Y. (at ovens):													
1932	8.00	8.00	7.60	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.59
1933	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
1934	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Chicago, Ill. (at ovens):													
1932	7.50	7.50	7.50	7.50	7.30	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.19
1933	7.00	7.00	7.00	7.00	7.00	7.15	7.50	7.50	8.00	8.00	8.00	8.00	7.43
1934	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
Detroit, Mich. (at ovens):													
1932	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
1933	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
1934	8.00	8.00	8.15	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.39
Indianapolis, Ind. (delivered at consumers' works):													
1932	8.30	8.30	8.25	8.25	8.25	8.25	8.25	8.25	8.25	8.15	7.75	7.75	8.17
1933	7.75	7.75	7.75	7.75	7.57	7.57	8.05	8.25	8.75	8.75	8.75	8.75	8.15
1934	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75
Newark, N. J. (delivered at consumers' works):													
1932	8.76	8.76	8.76	8.76	8.23	8.21	8.21	8.21	8.21	8.21	8.21	8.21	8.40
1933	8.21	8.21	8.21	8.21	8.21	8.21	8.21	8.21	8.51	8.71	8.71	8.71	8.36
1934	8.71	8.71	8.71	8.71	8.71	8.71	8.71	8.71	8.71	8.71	8.71	8.71	8.71
New England (delivered at consumers' works):													
1932	10.50	10.50	10.50	10.50	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.17
1933	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.30	10.50	10.50	10.50	10.15
1934	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.50	10.87	11.00	10.57
Philadelphia, Pa. (delivered at consumers' works):													
1932	8.75	8.75	8.75	8.75	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.58
1933	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.63	9.00	9.00	9.00	8.64
1934	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Portsmouth, Ohio (at ovens):[1]													
1932	5.50	5.50	5.50	5.50	5.50	5.00	4.50	4.50	4.50	4.50	4.50	4.50	4.96
1933	4.50	4.50	4.50	4.50	4.50	4.50	4.80	5.00	5.50	5.50	5.50	5.60	4.91
1934	6.00	6.00	[2]6.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
St. Louis, Mo. (at ovens):													
1932	8.50	8.50	8.50	8.50	8.50	7.95	7.75	7.75	7.75	7.75	7.75	7.75	8.08
1933	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75	8.15	8.50	8.75	9.00	8.03
1934	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25

[1] Prices at ovens, Ashland and Portsmouth, quoted on Connellsville ovens basis.
[2] Discontinued after Mar. 12, 1934.

SHIPMENTS BY RAIL AND WATER

TABLE 37.—*Beehive coke loaded for shipment on originating railroads in the United States in 1934, by routes, as reported by coke producers* [1]

Route	State	Quantity (net tons)		Percent of total
		By States	Total	
Railroads:				
Baltimore & Ohio	Pennsylvania West Virginia	41,618 27,803	69,421	6.8
Chesapeake & Ohio	do	55,647	55,647	5.5
Denver & Rio Grande Western	Colorado Utah	38,657 13,804	52,461	5.2
Huntingdon & Broad Top Mountain	Pennsylvania	3,564	3,564	.3
Interstate	Virginia	56,977	56,977	5.6
Ligonier Valley	Pennsylvania	76,534	76,534	7.5
Monongahela	do	293,205	293,205	28.8
Nashville, Chattanooga & St. Louis	Tennessee	3,568	3,568	.3
New York Central	West Virginia	88,573	88,573	8.7
Norfolk & Western	Virginia	21,907	21,907	2.1
Northern Pacific	Washington	1,694	1,694	.2
Pennsylvania	Pennsylvania	288,799	288,799	28.4
Pittsburgh & Lake Erie	do	2,980	2,980	.3
Southern	Tennessee	2,734	2,734	.3
Total railroad shipments		1,018,064	1,018,064	100.0

[1] There were no shipments of beehive coke over waterways during 1934.

EXPORTS AND IMPORTS [1]

TABLE 38.—*Coke exported from the United States, 1932–34, by customs districts*

District	1932		1933		1934	
	Net tons	Value	Net tons	Value	Net tons	Value
Alaska			1	$6		
Arizona			52	310	102	$897
Buffalo	134,823	$681,190	119,360	600,916	313,425	1,792,771
Chicago	27,079	87,975	33,104	107,590	58,148	270,709
Dakota	4,404	25,019	7,386	41,093		
Duluth-Superior	1,643	11,323	1,569	10,107	1,845	12,879
El Paso	4	77	7	104	4	65
Florida	1,015	9,866	1,101	7,635	7,247	73,261
Los Angeles					1	10
Maine and New Hampshire	125	752	35	236		
Maryland			144	1,539	2,355	9,510
Michigan	370,643	1,587,668	444,110	1,875,641	492,549	2,853,333
Mobile	2,240	31,000	1,816	4,858	5,002	15,580
Montana and Idaho					8,623	54,883
New Orleans	9,530	42,623	1,388	8,782	7,622	53,888
New York	155	2,315	250	3,563	403	6,831
Ohio	76,216	294,061	22,514	98,445	41,697	223,036
Oregon					30	180
Philadelphia	2	24	6	60	2,483	39,398
Puerto Rico	36	520	21	216	40	467
Sabine			2,240	21,400		
St. Lawrence	612	4,511	319	1,790	723	7,523
San Antonio	21	103	483	2,730	4	74
San Diego	363	3,169	157	1,619	145	1,722
San Francisco	9	152	346	2,863	9	130
Vermont	84	573	27	175		
Virginia	1,147	8,028	231	1,409	320	2,482
Washington			1,152	4,034	8	109
Total	630,151	2,790,949	637,819	2,797,121	942,785	5,419,738

[1] Figures on exports and imports, unless otherwise indicated, compiled by the Bureau of Mines from records of the Bureau of Foreign and Domestic Commerce.

TABLE 39.—*Coke exported from the United States, 1932–34, by countries of destination*

Destination	1932		1933		1934	
	Net tons	Value	Net tons	Value	Net tons	Value
North America:						
Bermudas	12	$184	13	$178	11	$170
Canada	615, 629	2, 693, 072	631, 820	2, 761, 433	917, 018	5, 215, 243
Central America:						
Costa Rica	7	116	8	94	40	617
Guatemala	36	381	18	224	80	1, 152
Honduras	31	429	44	629	54	744
Nicaragua	23	395	74	1, 221	40	770
Panama	329	3, 983	224	1, 085	115	1, 869
Salvador	11	95	17	215	38	587
Mexico	424	3, 645	828	6, 261	316	3, 589
West Indies:						
British	9	48	2	29		
Cuba	9, 421	40, 458	3, 561	13, 332	14, 034	66, 053
Dominican Republic	42	662	50	746	57	794
French			200	1, 210	20	93
Haiti	9	123	10	178	3	67
Netherland	3	34			18	152
South America:						
Bolivia					88	1, 446
Chile					2, 346	9, 559
Colombia	74	1, 055	59	755	120	1, 857
Ecuador	25	361	22	280	29	458
Peru					123	1, 680
Venezuela	7	105	17	187	44	733
Europe:						
Belgium			78	1, 040	213	3, 000
France	2, 296	31, 775			601	9, 197
Italy	1, 763	14, 028	359	4, 676	6, 543	88, 362
Netherlands			4	19		
Norway					568	9, 139
Sweden					30	180
United Kingdom			90	865	6	78
Asia:						
China					31	556
Philippine Islands			321	2, 464	199	1, 593
Total	630, 151	2, 790, 949	637, 819	2, 797, 121	942, 785	5, 419, 738

TABLE 40.—*Coke imported into the United States, 1932–34, by customs districts* [1]

District	1932		1933		1934	
	Net tons	Value	Net tons	Value	Net tons	Value
Buffalo					13, 027	$229, 631
Connecticut					3, 298	15, 819
Hawaii	224	$1, 068	400	$3, 480	426	4, 085
Los Angeles	14, 391	43, 461	15, 820	36, 904	21, 759	72, 712
Massachusetts	79, 186	256, 623	101, 096	318, 569	77, 336	355, 573
Maine and New Hampshire	672	3, 086	2	16	197	1, 470
Michigan					579	8, 718
Montana and Idaho					7, 292	39, 473
New York	2, 517	9, 160	7, 393	25, 861		
Oregon	1, 255	3, 133	2, 107	5, 123	2, 593	9, 009
Rhode Island			8, 182	25, 547	10, 036	41, 994
San Antonio					1, 928	8, 679
San Francisco	16, 304	46, 017	21, 774	58, 273	17, 582	61, 127
Vermont					35	248
Washington	2, 726	7, 340	4, 099	9, 949	4, 846	16, 313
Total	117, 275	369, 888	160, 873	483, 722	160, 934	864, 851

[1] Prior to 1934 the figures represent general imports; beginning with 1934 they represent imports for consumption only.

TABLE 41.—*Coke imported into the United States, 1932–34, by countries of origin* [1]

Country	1932		1933		1934	
	Net tons	Value	Net tons	Value	Net tons	Value
Belgium	17,930	$59,246	9,544	$19,292	1,711	$4,914
Canada					21,130	279,540
Germany	16,660	70,363	44,133	117,786	29,847	128,627
Japan			7	31		
Mexico			777	2,464	1,928	8,679
Netherlands	8,386	27,677				
United Kingdom	74,299	212,602	106,412	344,149	106,318	443,091
Total	117,275	369,888	160,873	483,722	160,934	864,851

[1] Prior to 1934 the figures represent general imports; beginning with 1934 they represent imports for consumption only.

WORLD PRODUCTION

TABLE 42.—*Coke produced in principal countries, 1929 and 1931–34, in metric tons* [1]

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1929	1931	1932	1933	1934
Australia:					
New South Wales	471,813	221,000	362,217	481,026	(2)
Queensland	4,144	2,317	1,963	15,337	(2)
Belgium	6,192,960	5,129,960	4,682,860	4,694,130	4,363,200
Bulgaria			566	628	(2)
Canada	1,986,532	1,256,010	1,074,895	1,228,246	1,657,652
China (exports)	13,467	8,130	4,113	1,709	(2)
Chosen	(3)	154,918	212,489	(3)	(2)
Czechoslovakia	3,170,629	2,046,371	1,277,810	1,259,381	1,344,800
France	9,080,127	7,940,000	5,868,000	6,792,000	7,270,000
Germany [4]	39,421,033	23,189,836	19,545,920	20,713,502	24,218,406
Saar	2,423,000	1,941,000	1,685,000	1,880,000	2,179,539
Great Britain [5]	13,637,421	8,606,664	8,616,303	8,919,540	(2)
Hungary	2,092	2,184	(3)	(3)	(2)
India, British [6]	843,504	1,330,322	1,234,019	1,246,886	(2)
Indo-China	637	1,000	2,150	360	(2)
Italy	791,607	740,266	714,141	729,966	(2)
Japan:					
Manufactured coke	(3)	(3)	(3)	(3)	(2)
Natural coke	(3)	180,751	279,010	370,785	(2)
Mexico	493,777	350,201	255,595	251,604	275,176
Netherlands	2,402,566	2,739,343	2,519,656	2,609,373	(2)
Peru	35,899	9,269	(3)	(3)	(2)
Poland	1,858,052	1,354,743	1,090,900	1,170,717	1,333,493
Rhodesia, Southern	100,001	39,866	25,514	31,798	(2)
Spain	768,040	503,115	369,352	427,453	(2)
Sweden	103,778	126,642	106,328	103,336	(2)
U. S. S. R. (Russia)	(3)	6,800,000	8,200,000	10,200,000	14,200,000
Union of South Africa	99,297	86,371	57,347	75,456	72,969
United States	54,325,427	30,375,912	19,766,300	25,028,365	28,867,897
Total	144,766,000	96,386,000	79,214,000	89,694,000	(2)

[1] Gas-house coke is not included.
[2] Data not available.
[3] Estimate included in total.
[4] Exclusive of the Saar, which is shown separately.
[5] In Great Britain the production of gas-house coke (including breeze), not included above, is especially important and was as follows: 1930, 12,514,392 tons; 1931, 12,301,695 tons; 1932, 11,990,229 tons; 1933, 11,657,081 tons.
[6] Figures for 1929 represent "hard" and "soft" coke made at collieries only (73,616 tons of "hard" coke and 769,888 tons of "soft" coke). Data for other years shown represent total "hard" coke manufactured. In addition, the following quantities of "soft" coke were made at collieries: 1931, 735,799 tons; 1932, 772,430 tons; 1933, data not available.

COKE-OVEN BYPRODUCTS

SUMMARY OF BYPRODUCTS IN 1934

TABLE 43.—*Byproducts obtained from coke-oven operations in the United States in 1934* [1]

[Exclusive of screenings or breeze]

Product	Production	Sales		
		Quantity	Value	
			Total	Average
Tar...gallons..	408,710,314	273,763,739	$10,760,125	$0.039
Ammonia:				
Sulphate...pounds..	785,444,684	777,115,791	7,501,160	.010
Ammonia liquor (NH_3 content)...do....	43,593,977	41,734,652	1,230,349	.029
			8,731,509	
Sulphate equivalent of all forms...do....	959,820,592	944,054,399		
Gas:				
Used under boilers, etc...M cubic feet..	[2] 493,581,751	29,324,006	2,873,573	.098
Used in steel or affiliated plants...do....		119,716,459	11,001,864	.092
Distributed through city mains...do....		144,308,149	42,925,575	.297
Sold for industrial use...do....		16,222,743	2,457,827	.152
		309,571,357	59,258,839	.191
Light oil and derivatives:				
Crude light oil...gallons..	[3] 115,694,748	11,648,726	978,260	.084
Benzol, crude and refined...do....	21,690,879	17,743,944	2,778,870	.157
Motor benzol...do....	50,046,610	49,224,891	4,615,604	.094
Toluol, crude and refined...do....	13,281,794	13,240,880	3,638,031	.275
Solvent naphtha...do....	3,048,744	2,881,531	502,478	.174
Xylol...do....	2,736,295	2,752,302	633,341	.230
Other light-oil products...do....	3,765,817	1,350,270	70,945	.053
	[4] 94,570,139	98,842,544	13,217,529	.134
Naphthalene, crude and refined...pounds..	10,743,471	10,500,285	131,299	.013
Tar derivatives:				
Creosote oil, distillate as such...gallons..	11,571,143	5,302,775	439,858	.083
Creosote oil in coal-tar solution...do....	836,867	197,710	16,696	.084
Pitch of tar...net tons..	97,898	4,937	31,478	6.376
Other tar derivatives...			167,182	
Phenol...gallons..	68,609	68,358	19,049	.279
Other products [5]...			92,264	
Value of all byproducts sold...			[6] 92,865,828	

[1] Includes products of tar distillation conducted by coke-oven operators under same corporate name, except, however, phenol and other tar acids produced at Clairton, Pa.
[2] Includes gas wasted and gas used for heating retorts.
[3] Refined on the premises to make the derived products shown, 108,219,464 gallons.
[4] Total gallons of derived products.
[5] Ammonia thiocyanate, carbolates, cyanogen, insecticides, pyridine oil, sodium prussiate, sulphur, and vented vapors.
[6] Exclusive of the value of breeze production, which in 1934 amounted to $5,691,136.

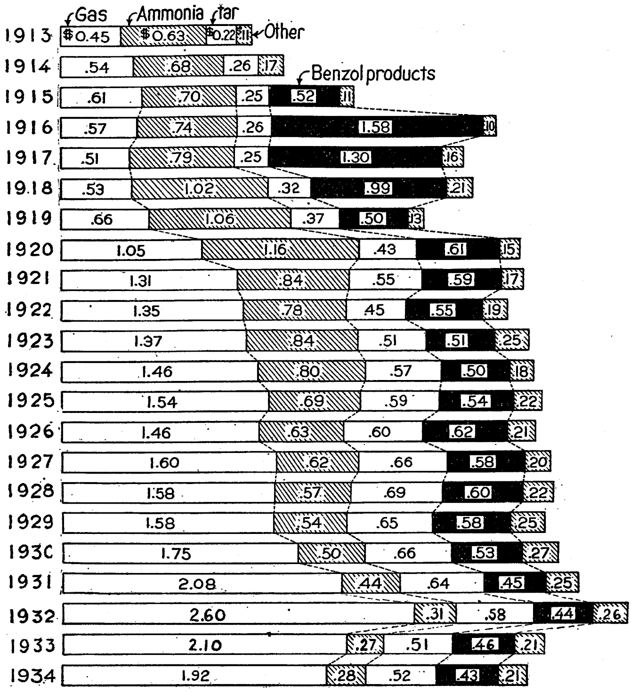

FIGURE 55.—Gross value of the several byproducts per ton of byproduct coke produced, 1913–34.

TABLE 44.—*Coal equivalent of byproducts of byproduct coking, 1913, 1914, 1918, and 1932–34*

Year	Quantity of byproducts				Rough equivalent in heating value (billion B. t. u.)					Coal equivalent	
	1	2	3	4	5	6	7	8	9	10	11
	Coke breeze (thousand net tons)	Surplus gas (billion cubic feet)	Tar produced (thousand gallons)	Light oil produced (thousand gallons)	Coke breeze (1×20)	Surplus gas (2×550)	Tar (3×0.150)	Light oil (4×0.130)	Total (5+6+7+8)	Net tons (9÷0.0262)	Percent this forms of coal made into coke
1913	735	64	115, 145	3, 000	14, 700	35, 200	17, 272	390	67, 562	2, 600, 000	3. 8
1914	667	61	109, 901	8, 464	13, 340	33, 550	16, 485	1, 100	64, 475	2, 461, 000	4. 8
1918	1, 999	158	263, 299	87, 562	39, 980	86, 900	39, 495	11, 383	177, 758	6, 785, 000	8. 0
1932	2, 119	231	303, 812	73, 763	42, 380	127, 050	45, 572	9, 589	224, 591	8, 572, 000	26. 9
1933	2, 533	276	363, 299	96, 632	50, 660	151, 800	54, 495	12, 562	269, 517	10, 287, 000	25. 7
1934	2, 731	310	408, 710	115, 695	54, 620	170, 500	61, 307	15, 040	301, 467	11, 506, 000	25. 0

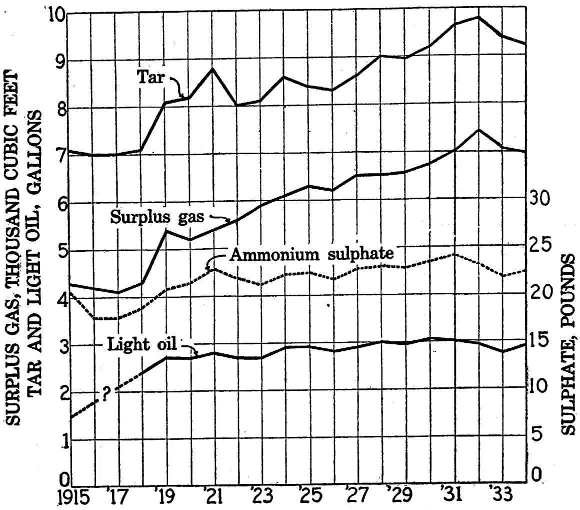

FIGURE 56.—Average yield of principal byproducts per net ton of coal carbonized in byproduct coke ovens, 1915–34. Figures for light oil represent average at plants recovering light oil.

COKE-OVEN GAS

TABLE 45.—*Coke-oven gas produced and sold in the United States in 1934, by States*

State	Number of active plants	Produced (M cubic feet)	Used in heating ovens (M cubic feet)	Surplus sold or used: M cubic feet	Surplus sold or used: Value: Total	Surplus sold or used: Value: Average	Wasted (M cubic feet)
Alabama	6	33, 973, 700	14, 925, 140	17, 759, 980	$1, 352, 932	$0. 076	1, 288, 580
Colorado	1	3, 224, 202	2, 186, 557	1, 024, 075	(1)	(1)	13, 570
Illinois	7	25, 177, 759	5, 487, 421	19, 619, 621	4, 521, 299	. 230	70, 717
Indiana	6	39, 686, 569	18, 410, 912	20, 732, 181	3, 604, 502	. 174	543, 476
Maryland	1	12, 101, 121	3, 368, 512	8, 732, 609	(1)	(1)	----------
Massachusetts	3	19, 557, 307	6, 395, 756	13, 107, 491	3, 762, 471	. 287	54, 060
Michigan	8	43, 601, 795	15, 559, 334	27, 889, 748	5, 607, 611	. 201	152, 713
Minnesota	2	6, 754, 094	2, 644, 586	4, 103, 088	(1)	(1)	6, 420
New Jersey	2	14, 972, 428	3, 352, 020	11, 620, 408	(1)	(1)	----------
New York	9	63, 871, 640	14, 150, 480	46, 400, 688	14, 838, 788	. 320	3, 320, 472
Ohio	13	64, 572, 743	27, 184, 886	36, 349, 939	4, 031, 908	. 111	1, 037, 918
Pennsylvania	12	113, 654, 274	47, 340, 167	64, 948, 812	8, 962, 695	. 138	1, 365, 295
Tennessee	1	959, 410	431, 645	527, 765	138, 024	. 262	----------
Utah	1	2, 413, 421	1, 148, 296	1, 248, 175	(1)	(1)	16, 950
Washington	1	577, 866	------------	513, 836	155, 054	. 302	64, 030
West Virginia	4	22, 071, 505	6, 708, 463	15, 334, 259	1, 341, 034	. 087	28, 783
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	6	26, 411, 917	6, 574, 348	19, 658, 682	5, 661, 957	. 288	178, 887
Undistributed	-------	------------	------------	------------	5, 280, 564	. 198	----------
Grand total, 1934	83	493, 581, 751	175, 868, 523	309, 571, 357	59, 258, 839	. 191	8, 141, 871
At merchant plants	42	186, 572, 499	47, 577, 586	135, 317, 760	38, 741, 119	. 286	3, 677, 153
At furnace plants	41	307, 009, 252	128, 290, 937	174, 253, 597	20, 517, 720	. 118	4, 464, 718
Grand total, 1933	85	431, 291, 780	147, 783, 128	276, 146, 629	55, 997, 694	. 203	7, 362, 023
Change, 1934 ....percent	−2. 4	+14. 4	+19. 0	+12. 1	+5. 8	−5. 9	+10. 6

[1] Included under "Undistributed."

TABLE 46.—*Disposition of surplus coke-oven gas in the United States in 1934, by States*

State	Used by producer					
	Under boilers			In steel or other affiliated plants		
	M cubic feet	Value: Total	Value: Average	M cubic feet	Value: Total	Value: Average
Alabama	5,005,448	$257,868	$0.052	9,145,292	$612,187	$0.067
Colorado				1,024,075	(1)	(1)
Illinois	1,057,510	68,771	.065	665,966	87,647	.132
Indiana	364,282	27,848	.076	13,892,615	1,689,909	.122
Maryland				4,359,178	(1)	(1)
Massachusetts	1,715	(1)	(1)			
Michigan	12,672,320	1,891,936	.149			
Minnesota	75,527	(1)	(1)			
New Jersey						
New York	2,320,933	137,934	.059	8,070,114	802,423	.099
Ohio	1,698,346	105,558	.062	28,183,437	2,850,391	.101
Pennsylvania	2,816,537	181,137	.064	42,879,116	3,593,816	.084
Tennessee	115,450	4,041	.035			
Utah	800,771	(1)	(1)	27,120	(1)	(1)
Washington				2,258	1,581	.700
West Virginia	1,752,748	83,565	.048	11,464,350	926,775	.081
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	642,419	65,703	.102	2,938	708	.241
Undistributed		49,212	.056		436,427	.081
Grand total, 1934	29,324,006	2,873,573	.098	119,716,459	11,001,864	.092
At merchant plants	8,896,526	560,481	.063	741,817	81,777	.110
At furnace plants	20,427,480	2,313,092	.113	118,974,642	10,920,087	.092
Grand total, 1933	26,110,163	2,324,198	.089	94,857,261	8,600,316	.091
Change, 1934 ... per cent	+12.3	+23.6	+10.1	+26.2	+27.9	+1.1

State	Sold					
	Distributed through city mains			Sold for industrial purposes		
	M cubic feet	Value: Total	Value: Average	M cubic feet	Value: Total	Value: Average
Alabama	1,603,253	$216,758	$0.135	2,005,987	$266,119	$0.133
Colorado						
Illinois	17,896,145	4,364,881	.244			
Indiana	5,483,527	1,690,541	.308	991,757	196,204	.198
Maryland	4,373,431	(1)	(1)			
Massachusetts	13,076,259	3,757,787	.287	29,517	(1)	(1)
Michigan	14,883,836	3,635,623	.244	333,592	80,052	.240
Minnesota	4,027,561	(1)	(1)			
New Jersey	11,620,408	(1)	(1)			
New York	34,408,664	13,579,696	.395	1,600,977	318,735	.199
Ohio	3,951,658	812,305	.206	2,516,498	263,654	.105
Pennsylvania	14,938,082	4,482,908	.300	4,315,077	704,834	.163
Tennessee	412,315	133,983	.325			
Utah	323,255	(1)	(1)	97,029	(1)	(1)
Washington	294,720	88,416	.300	216,858	65,057	.300
West Virginia				2,117,161	330,694	.156
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	17,015,035	5,376,760	.316	1,998,290	218,786	.109
Undistributed		4,785,917	.235		13,692	.108
Grand total, 1934	144,308,149	42,925,575	.297	16,222,743	2,457,827	.152
At merchant plants	116,679,201	36,772,872	.315	9,000,216	1,325,989	.150
At furnace plants	27,628,948	6,152,703	.223	7,222,527	1,131,838	.123
Grand total, 1933	135,589,195	41,119,384	.303	19,590,010	3,953,796	.202
Change, 1934 ... percent	+6.4	+4.4	−2.0	−17.2	−37.8	−24.8

(1) Included under "Undistributed."

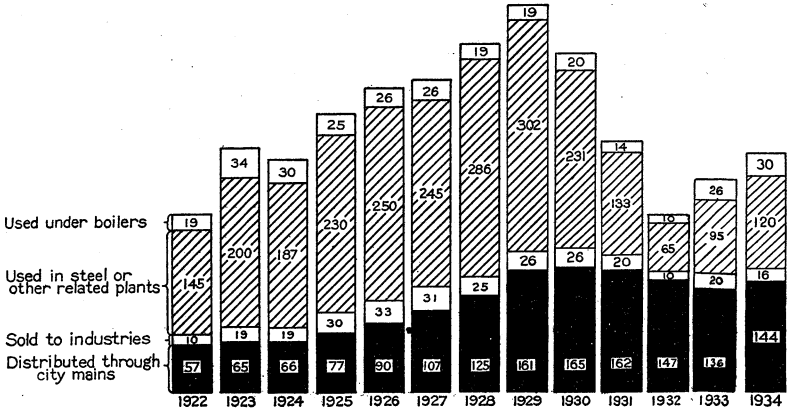

FIGURE 57.—Disposition of surplus coke-oven gas, 1922–34. Gas used in heating ovens or wasted, not included. Figures in bars represent billions of cubic feet.

TAR

TABLE 47.—*Coke-oven tar produced and sold in the United States in 1934, by States* [1]

State	Total produced	Yield of tar per ton of coal coked	Sold: For use as fuel [2]	Sold: For refining into tar products	Sold: Total sold	Sold: Value: Total	Sold: Value: Average
	Gallons	*Gallons*	*Gallons*	*Gallons*	*Gallons*		
Alabama	28,858,267	9.54	8,147,424	10,888,057	19,035,481	$740,604	$0.039
Colorado	2,817,500	10.90	----------	985	985	(3)	(3)
Illinois	21,727,894	8.88	----------	22,811,882	22,811,882	875,567	.038
Indiana	24,863,541	6.80	434,519	15,735,312	16,169,831	609,024	.038
Maryland	8,378,536	7.61	----------	7,612,283	7,612,283	(3)	(3)
Massachusetts	13,163,464	8.31	652,539	14,462,475	15,115,014	756,602	.050
Michigan	30,891,851	8.55	23,746	19,231,714	19,255,460	596,791	.031
Minnesota	4,949,508	8.12	----------	4,919,812	4,919,812	(3)	(3)
New Jersey	10,215,394	7.89	----------	10,473,669	10,473,669	(3)	(3)
New York	55,873,970	9.53	15,030,753	39,062,436	54,093,189	2,045,419	.038
Ohio	55,486,262	9.09	3,653,278	27,340,739	30,994,017	1,251,939	.040
Pennsylvania	107,765,616	10.69	6,251,277	24,693,924	30,945,201	1,169,633	.038
Tennessee	574,853	5.69	----------	615,859	615,859	30,793	.045
Utah	1,948,571	10.04	----------	1,867,672	1,867,672	(3)	(3)
Washington	340,436	6.80	318,875	----------	318,875	14,679	.046
West Virginia	22,259,628	11.53	2,785,409	17,592,037	20,377,446	751,333	.037
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin	18,595,023	7.81	----------	19,157,063	19,157,063	765,197	.040
Undistributed	----------	----------	----------	----------	----------	1,152,544	.046
Grand total, 1934	408,710,314	9.22	37,297,820	236,465,919	273,763,739	10,760,125	.039
At merchant plants	144,002,043	8.75	14,185,578	133,677,534	147,863,112	5,736,441	.039
At furnace plants	264,708,271	9.49	23,112,242	102,788,385	125,900,627	5,023,684	.040
Grand total, 1933	363,298,586	9.39	53,990,563	187,009,537	241,000,100	8,980,956	.037
Change, 1934 .... percent	+12.5	−1.8	−30.9	+26.5	+13.6	+19.8	+5.4

[1] This table excludes the quantity of tar "refined at plant", which in 1934 was 36,343,769 gallons.
[2] Includes 9,409,559 gallons sold to affiliated corporations and 27,888,261 gallons sold to other purchasers.
[3] Included under "Undistributed."

TABLE 47.—*Coke-oven tar produced and sold in the United States in 1934, by States*—Continued

State	Used by producer			On hand Dec. 31
	As fuel under boilers	In open-hearth or affiliated plants	Other-wise	
	Gallons	*Gallons*	*Gallons*	*Gallons*
Alabama		10,878,016	151,136	2,670,795
Colorado		102,014	14,495	389,411
Illinois		45,747		996,069
Indiana		9,917,715	250,029	2,781,101
Maryland		66,913		1,448,573
Massachusetts				228,890
Michigan		12,469,118		1,614,614
Minnesota				242,454
New Jersey				549,291
New York		1,847,854	262,607	4,970,302
Ohio	273,130	23,998,214	250	1,689,609
Pennsylvania	1,571,312	44,209,820	608,724	7,970,680
Tennessee				38,497
Utah		600	1,690	164,133
Washington	5,400		720	34,683
West Virginia		2,244,040	278	430,883
Connecticut, Kentucky, Missouri, Rhode Island, and Wisconsin			1,200	982,189
Undistributed				
Grand total, 1934	1,849,842	105,780,051	1,291,129	27,202,174
At merchant plants	5,400		264,805	7,258,520
At furnace plants	1,844,442	105,780,051	1,026,324	19,943,654
Grand total, 1933	[4] 6,915,963	[4] 107,458,097	517,218	37,497,766
Change, 1934 ... per cent	[4] −273.9	[4] −1.6	+149.6	−27.5

[4] The figures for 1933 include a certain quantity of pitch of tar derived from the item "refined at plant" and mixed with virgin tar for use as fuel. Because of this, the figures are not exactly comparable with 1934.

AMMONIA

TABLE 48.—*Ammonia produced at coke-oven plants in 1934, by States, in pounds*

State	Number of active plants	Sulphate equivalent of all forms		Produced as—	
		Total	Per ton of coal coked	Sulphate	Liquor (NH_3 content)
Alabama	6	79,243,688	26.20	77,732,792	377,724
Colorado	1	6,185,000	23.93	6,185,000	
Illinois	7	56,572,853	23.13	40,843,953	3,932,225
Indiana	6	66,223,938	18.10	57,473,230	2,187,677
Maryland	1	23,050,297	20.95	23,050,297	
Massachusetts	3	35,236,642	22.25	33,979,710	314,233
Michigan	8	79,432,418	22.00	35,505,310	10,981,777
New Jersey	2	25,740,724	19.88	25,740,724	
New York	9	128,810,011	21.97	98,533,347	7,569,166
Ohio	13	130,879,752	21.45	95,617,224	8,815,632
Pennsylvania	12	236,954,502	23.50	225,042,730	2,977,943
Tennessee	1	2,489,137	24.65	2,489,137	
Utah	1	4,646,366	23.93	4,646,366	
West Virginia	3	41,376,391	23.62	41,376,391	
Connecticut, Kentucky, Missouri, and Wisconsin	4	42,978,873	21.64	17,228 473	6,437,600
Grand total, 1934	77	959,820,592	22.29	785,444,684	43,593,977
At merchant plants	37	334,396,828	21.76	194,884,560	34,878,067
At furnace plants	40	625,423,764	22.58	590,560,124	8,715,910
Grand total, 1933	80	840,585,150	22.18	678,558,802	40,506,587
Change, 1934 ... percent	−3.7	+14.2	+0.5	+15.8	+7.6

LIGHT OIL AND ITS DERIVATIVES

TABLE 49.—*Crude light oil produced at coke-oven plants in the United States in 1934, by States, in gallons* [1]

State	Number of active plants	Produced: Total	Produced: Per ton of coal coked	Refined on premises	Total derived products obtained from refining operations
Alabama	5	8,871,284	2.94	8,870,527	7,201,434
Colorado	1	867,061	3.36	870,463	669,652
Illinois	5	5,472,558	2.48	1,759,584	1,428,682
Indiana	4	8,966,543	2.89	8,962,749	7,942,974
Maryland	1	3,836,889	3.49	3,834,607	3,264,982
Michigan	3	8,413,609	2.55	4,827,231	6,981,773
New York	8	11,698,418	2.29	18,565,123	15,768,071
Ohio	13	18,402,089	3.02	16,198,133	13,015,896
Pennsylvania	10	30,838,294	3.40	30,101,241	26,272,490
Tennessee	1	252,250	2.50	249,733	181,503
Utah	1	698,923	3.60	690,729	503,757
West Virginia	4	6,169,444	3.11	6,149,809	5,243,901
Kentucky, Massachusetts, Minnesota, Missouri, New Jersey, and Wisconsin	6	11,207,386	2.53	7,139,535	6,095,024
Grand total, 1934	62	115,694,748	2.90	108,219,464	94,570,139
At merchant plants	24	29,776,234	2.36	24,251,617	20,399,614
At furnace plants	38	85,918,514	3.14	83,967,847	74,170,525
Grand total, 1933	63	96,632,316	2.79	92,895,870	77,514,644
Change, 1934 ... percent	−1.6	+19.7	+3.9	+16.5	+22.0

[1] In addition to the quantity refined on the premises a few plants reported the sale of crude light oil. The total quantity sold in 1934 was 11,648,726 gallons valued at $978,260 or 8.4 cents per gallon.

NAPHTHALENE

TABLE 50.—*Naphthalene sold by byproduct coke operators, 1918 and 1931–34*

Year	Quantity (pounds): Crude	Quantity (pounds): Refined	Quantity (pounds): Total	Value	Average receipts per pound (cents): Crude	Average receipts per pound (cents): Refined	Receipts per ton of coke (cents)
1918	10,403,758	5,486,689	15,890,447	$650,229	2.8	6.6	2.5
1931	[1] 7,360,309		7,360,309	78,946	[1] 1.1		.2
1932	[1] 3,714,604		3,714,604	33,323	[1] .9		.2
1933	[1] 6,523,204		6,523,204	67,472	[1] 1.0		.3
1934	[1] 10,500,285		10,500,285	131,299	[1] 1.3		.4

[1] Crude and refined not separated.

BYPRODUCT COKE OVENS OWNED BY CITY GAS COMPANIES, INCLUDED BY BUREAU OF THE CENSUS IN MANUFACTURED-GAS INDUSTRY

TABLE 51.—*Production of coke, breeze, gas, and byproducts at byproduct coke plants owned by city gas companies (public utilities) and included by Bureau of the Census in manufactured-gas industry, and at all other byproduct coke plants, 1933 and 1934*

Product	1933			1934		
	Plants not owned by city gas companies	Plants owned by city gas companies (public utilities) [1]	Total	Plants not owned by city gas companies	Plants owned by city gas companies (public utilities) [1]	Total
Number of active plants	62	23	85	60	23	83
Coke:						
Production ..... net tons	23, 557, 115	3, 121, 021	26, 678, 136	27, 423, 082	3, 369, 729	30, 792, 811
Value	$101, 901, 297	$18, 411, 027	$120, 312, 324	$133, 771, 616	$21, 773, 914	$155, 545, 530
Average value	$4. 33	$5. 90	$4. 51	$4. 88	$6. 46	$5. 05
Screenings or breeze:						
Production ..... net tons	2, 164, 889	368, 492	2, 533, 381	2, 339, 410	391, 231	2, 730, 641
Sales ..... do	588, 811	36, 719	625, 530	627, 554	48, 413	675, 967
Value	$1, 138, 844	$92, 646	$1, 231, 490	$1, 315, 482	$126, 088	$1, 441, 570
Average value	$1. 93	$2. 52	$1. 97	$2. 10	$2. 60	$2. 13
Coal charged into ovens:						
Quantity ..... net tons	33, 982, 120	4, 698, 817	38, 680, 937	39, 326, 195	5, 016, 803	44, 342, 998
Coke:						
Used by producer:						
Quantity ..... net tons	12, 795, 295	647, 532	13, 442, 827	14, 658, 519	654, 616	15, 313, 135
Value	$50, 560, 918	$3, 831, 510	$54, 392, 428	$63, 116, 155	$4, 157, 406	$67, 273, 561
Sales:						
Quantity ..... net tons	11, 142, 719	2, 684, 107	13, 826, 826	12, 299, 170	2, 546, 095	14, 845, 265
Value	$53, 212, 402	$15, 823, 078	$69, 035, 480	$68, 175, 065	$16, 511, 220	$84, 686, 285
Byproducts:						
Gas:						
Production .. M cubic feet	375, 122, 227	56, 169, 553	431, 291, 780	434, 353, 117	59, 228, 634	493, 581, 751
Sales of surplus:						
Used under boilers:						
Quantity . M cubic feet	26, 065, 573	44, 590	26, 110, 163	29, 204, 285	119, 721	29, 324, 006
Value	$2, 313, 309	$10, 889	$2, 324, 198	$2, 859, 151	$14, 422	$2, 873, 573
Used in steel or affiliated plants:						
Quantity . M cubic feet	94, 838, 582	18, 679	94, 857, 261	119, 696, 884	19, 575	119, 716, 459
Value	$8, 589, 689	$10, 627	$8, 600, 316	$10, 990, 948	$10, 916	$11, 001, 864
Distributed through city mains:						
Quantity . M cubic feet	86, 979, 213	48, 609, 982	135, 589, 195	93, 633, 872	50, 674, 277	144, 308, 149
Value	$22, 632, 484	$18, 486, 900	$41, 119, 384	$24, 748, 296	$18, 177, 279	$42, 925, 575
Sold for industrial use:						
Quantity . M cubic feet	18, 298, 079	1, 291, 931	19, 590, 010	14, 663, 870	1, 558, 873	16, 222, 743
Value	$3, 548, 312	$405, 484	$3, 953, 796	$1, 995, 422	$462, 405	$2, 457, 827
Tar:						
Production ..... gallons	315, 117, 675	48, 180, 911	363, 298, 586	358, 920, 303	49, 790, 011	408, 710, 314
Sales:						
Quantity ..... do	194, 775, 329	46, 224, 771	241, 000, 100	221, 109, 325	52, 654, 414	273, 763, 739
Value	$7, 152, 129	$1, 828, 827	$8, 980, 956	$8, 732, 619	$2, 027, 506	$10, 760, 125
Average value	$0. 037	$0. 040	$0. 037	$0. 039	$0. 039	$0. 039
Ammonia:						
Production (NH_3 equivalent of all forms) . pounds	188, 706, 272	21, 440, 016	210, 146, 288	217, 214, 759	22, 740, 389	239, 955, 148
Liquor (NH_3 content):						
Production ..... pounds	36, 395, 407	4, 111, 180	40, 506, 587	39, 789, 057	3, 804, 920	43, 593, 977
Sales ..... do	36, 210, 271	4, 032, 610	40, 242, 881	37, 919, 092	3, 815, 560	41, 734, 652
Value	$1, 087, 970	$71, 917	$1, 159, 887	$1, 152, 577	$77, 772	$1, 230, 349
Sulphate:						
Production ..... pounds	609, 243, 459	69, 315, 343	678, 558, 802	709, 702, 808	75, 741, 876	785, 444, 684
Sales ..... do	589, 762, 574	73, 105, 666	662, 868, 240	708, 546, 445	68, 569, 346	777, 115, 791
Value	$5, 357, 139	$671, 626	$6, 028, 765	$6, 825, 251	$675, 909	$7, 501, 160
Crude light oil:						
Production ..... gallons	92, 881, 822	3, 750, 494	96, 632, 316	111, 588, 238	4, 106, 510	115, 694, 748
Sales ..... do	4, 698, 063	2, 880, 855	7, 578, 918	8, 546, 301	3, 102, 425	11, 648, 726
Value	$449, 730	$262, 947	$712, 677	$710, 361	$267, 899	$978, 260
Light-oil derivatives:						
Production ..... gallons	76, 865, 911	648, 733	77, 514, 644	93, 771, 926	798, 213	94, 570, 139
Sales ..... do	73, 396, 294	621, 056	74, 017, 350	86, 394, 090	799, 728	87, 193, 818
Value	$11, 482, 755	$110, 795	$11, 593, 550	$12, 098, 304	$140, 965	$12, 239, 269
Naphthalene, crude and refined:						
Production ..... pounds	6, 603, 139	14, 934	6, 618, 073	10, 735, 287	8, 184	10, 743, 471
Sales ..... do	6, 508, 270	14, 934	6, 523, 204	10, 492, 101	8, 184	10, 500, 285
Value	$67, 397	$75	$67, 472	$131, 176	$123	$131, 299
All other products, value	$580, 608	$6, 745	$587, 353	$757, 072	$9, 455	$766, 527

[1] Includes all byproduct ovens built by city gas companies, some of which are operated in conjunction with coal-, oil-, and water-gas plants. Does not include independent byproduct plants, which may sell gas to public utility companies for distribution.

RECENT DEVELOPMENTS IN COAL PREPARATION AND UTILIZATION

By A. C. FIELDNER

SUMMARY OUTLINE

The first annual review of this series (Minerals Yearbook 1932–33, pp. 433–445) presents the background for the new developments discussed in the subsequent years. Readers unfamiliar with the subject will find it helpful to read the above initial review and the following one in the 1934 Yearbook.

COMPOSITION, PROPERTIES, AND TESTING OF COAL

Tentative specifications for the classification of coals by rank and by grade were adopted by the American Society for Testing Materials in 1934.[1]

Microstructure and petrography.—Stopes [2] has expanded her original classification [3] of the banded constituents of coals to include vitrain showing microscopic plant structure (Thiessen's anthraxylon), which is given the name "pro-vitrain"; structureless vitrain is called "Eu-vitrain."

The importance of determining the composition and properties of the constituent types of coal in a given bed, as exemplified by the bright and dull bands, is receiving the increased recognition it deserves.[4 5 6] These layers often show wide variations in composition and coking properties. The bright bands are lower in ash and higher

[1] American Society for Testing Materials, Tentative Specifications for Classification of Coals by Rank and Grade: Proc. vol. 34, pt. I, 1934, pp. 834–842.

[2] Stopes, Marie C., On the Petrology of Banded Bituminous Coal: Fuel, vol. 14, 1935, pp. 4–13.

[3] Stopes, Marie C., On the Four Visible Ingredients in Banded Bituminous Coal: Studies in the Composition of Coal, no. 1, Proc. Royal Soc., London, vol. 90B, 1919, pp. 470–487.

[4] Brückner, Horst, and Ludewig, Walter, Bright and Dull Coals: Brennstoff-Chem., vol. 15, 1934, pp. 301–305.

[5] Drees, K., and Kowalski, G., Investigation of Bright and Dull Coals from Upper Silesian Seams: Brennstoff-Chem., vol. 15, 1934, pp. 221–229. Fuel, vol. 13, 1934, pp. 366–370; vol. 14, 1935, pp. 18–23.

[6] McCabe, L. C., Mitchell, D. R., and Cady, G. H., Contributions to the Study of Coal: Illinois State Geol. Survey Rept. of Investigations 34, 1934, pp. 7–44.

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in coking properties than the dull bands.[7] The differences between dull and bright coals become greater as the rank decreases.[8]

The friable constituents of coal, such as fusain, concentrate in the coal dust which settles in mines, imparting a different degree of inflammability to these dusts than that of a representative pulverized sample of the lump coal.[9]

The temperatures at which initial melting of certain constituents of coal takes place were determined at the Bureau of Mines by observing under the microscope thin sections of coal heated to various temperatures.[10]

Chemical constitution.—Work with solvents has contributed further evidence of the presence of 6-atom carbon rings in the coal substance.[11] The method of "rational" analysis, which depends largely on solvent extraction, did not prove useful as a test for predicting gas-, coke-, or byproduct-making properties of coals, when applied by the Bureau of Mines in its survey of coking coals.[12] Teskey [13] believes that during coal formation the humic acids pass through a series of compounds, each containing less oxygen than the preceding ones.

The Coal Research Laboratory of the Carnegie Institute of Technology, in its study of the constitution of coal, has developed equipment for the distillation of coal at temperatures up to 620° C. under a vacuum of 10^{-2} to 10^{-3} mm of mercury with minimum decomposition of products,[14] and for the pyrolysis of coal at controlled rates of heating to fixed maximum temperatures. It was found that the mechanism of coking involved competition between distillation and decomposition and that differences in the magnitude of their temperature coefficients were responsible for the increase in tar yield as the rate of heating was increased.[15]

Decomposition temperatures and plastic properties.—Hibbott and Wheeler [16] have described a method for estimating the decomposition temperature of bituminous coal, which involves raising the temperature of 1-gram samples of finely divided coal at the rate of 0.5° per minute and measuring periodically the volumes of gases withdrawn continuously by a vacuum pump. A sudden change occurs in the quantity of gases yielded by a coal when the decomposition point is reached. Lignites [17] do not give a sudden evolution of gases at the decomposition point, but significant changes occur in the character of the gaseous and liquid products and in the solid residues. Kreulen [18]

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7 Sprunk, G. C., and Thiessen, R., Relation of Microscopic Composition of Coal to Chemical, Coking and Byproduct Properties: Ind. and Eng. Chem., vol. 27, 1935, pp. 446–451.

8 Pieters, H. A. J., and Koopmans, H., New Views in Coal Chemistry. V. Oxidation of Coal: Het. Gas, vol. 54, 1934, pp. 71–82, 93–98; Chem. Abs., vol. 28, 1934, p. 3868.

9 Bode, H., Application of Results of Petrographic Investigation of Coal Dusts: Glückauf, vol. 70, 1934, pp. 525–529.

10 Thiessen, R., and Sprunk, G. C., The Effect of Heat on Coal as Revealed by the Microscope: Fuel, vol. 13, 1934, pp. 116–125.

11 Lowry, H. H., Thermal Decomposition of the "Coal Hydrocarbon": Ind. and Eng. Chem., vol. 26, 1934, pp. 320–324.

12 Kester, E. B., Schneider, E. J., and Jung, F. W., Significance of Solvent Extraction and Rational Analysis in Coal Carbonization: Ind. and Eng. Chem., anal. ed., vol. 6, 1934, pp. 98–103.

13 Teskey, Maurice F., The Nature and Origin of Coking Coals: Fuel, vol. 13, 1934, pp. 242–248.

14 Juettner, B., and Howard, H. C., Pyrolysis of Coal. Thermal Decomposition and Distillation of Coal in a High Vacuum: Ind. and Eng. Chem., vol. 26, 1934, pp. 1115–1118; Thermal Decomposition of a Coal in High Vacuum, Carnegie Inst. Technol., Coal Research Lab. Contrib. 8, 1934, 21 pp.

15 Warren, W. B., Carbonization of Coal. Evaluation of Effects of Rate of Heating and of Maximum Temperature on Pyrolysis of a Coking Coal: Ind. and Eng. Chem., vol. 27, 1935, pp. 72–77.

16 Hibbott, H. W., and Wheeler, R. V., Studies in the Composition of Coal. A Method of Estimating the Decomposition Points of Bituminous Coals: Jour. Chem. Soc., 1934, pp. 1084–1086.

17 Ashmore, J. E., and Wheeler, R. V., Studies in the Composition of Coal. The Thermal Decomposition of Lignites: Jour. Chem. Soc., 1934, pp. 474–480.

18 Kreulen, D. J. W., Procedure for Determining the Rate of Evolution of Gas from Coal: Fuel, vol. 13, 1934, pp. 190–191.

determined the rate of increase in evolution of volatile matter for each 10° rise in temperature from 200° to 650° C. for 23 coals. The temperature of maximum evolution of gas varied with the volatile matter content of the ash- and moisture-free coal, irrespective of the degree of coalification. Shimomura[19] developed an apparatus for the continuous measurement of the weight of volatile matter evolved on heating coal and applied this measurement, together with determinations of contraction or swelling in the plastic range, to determine the effect of blending coals.

The development of plasticity in coal on heating and its relation to coking have continued to interest European investigators.[20] Bunte and Löhr,[21] using the Layng-Hathorne modification of the Foxwell method involving resistance to the flow of nitrogen, conclude that the plastic behavior of a blend can not be predicted from that of the constituent coals. Scheutschenko[22] describes an automatically registering apparatus for determining the swelling pressure and the upper and lower levels of the plastic zone of coal during coking. Arnu[23] made further study of the dilatometer method of Audibert and Delmas and concludes that the method gives virtually all the properties necessary to determine the suitability of a coal for coking purposes. On the other hand, recent research by the Bureau of Mines,[24] wherein plastic properties and extractability were determined for 30 coking coals which were tested at the same time as to carbonizing properties, indicates that none of these tests can replace carbonization tests in predicting the quality of coke obtainable from a given coal.

Ignition temperature and oxidation.—Although coal has no definite ignition temperature from the physicochemical point of view, investigators[25] have continued to devise apparatus for measuring so-called ignition temperatures. Low-temperature (100°–120° C.) oxidation raises the ignition temperature,[26] modifies the agglutinating power[27], changes the reactivity,[28] and decreases the gas yield.[29] The addition of moisture to coal accelerates the absorption of oxygen.[30] The tendency of lignites to ignite spontaneously is related to the content of humic substances.[31] Lignites which contain least humic materials approach bituminous coals in their resistance to spontaneous com-

[19] Shimomura, A., A Study of Blending Coals for Coke Manufacture: Fuel, vol. 13, 1934, pp. 262–268.

[20] Freundlich, H., Plasticity the Servant of Industry: Jour. Chem. Ind., vol. 53, 1934, pp. 218T–224T; Discussion of Plasticity in Industry: Ibid, pp. 247T–250T.

[21] Bunte, Karl, and Löhr, Hans, The Softening Behavior of Coal and Coal Blends and Its Influence on Coke Characteristics, Especially Coke Strength: Gas u. Wasserfach, vol. 77, 1934, pp. 242–247, 261–269.

[22] Scheutschenko, E. P., Plastometric Examination of Coking Coals: Zavod. Lab., vol. 3, 1934, pp. 266–267.

[23] Arnu, Charles, The Study and Control of the Properties of Coking Coals by Means of the Dilatometer Method of Audibert and Delmas: Chal. et Ind., vol. 15, 1934, pp. 278–296.

[24] Fieldner, A. C., and Davis, J. D., Gas-, Coke-, and Byproduct-Making Properties of American Coals and Their Determination: Monograph 5, Bureau of Mines, 1934, 164 pp.

[25] Kreulen, J. W., The Determination of the Ignition Temperature and the "Humic-Acid Curve" of a Coal: Fuel, vol. 13, 1934, pp. 55–59. Vajagić, B., Determination of Ignition Point of Coal: Arhiv. Hem. Farm., vol. 8, 1934, pp. 110'–114; Chem. Abs., vol. 28, 1934, p. 5628.

[26] Peters, Kurt, and Cremer, Werner, The Oxidation Processes of Solid Fuels: Ztschr. angew. Chem., vol. 47, 1934, pp. 529–536; Chem. Abs., vol. 28, 1934, p. 6547.

[27] Agde, G., and Winter, A., Investigations of the Alteration of Cakability and Ignitibility of Oxidized Coals: Brennstoff-Chem., vol. 15, 1934, pp. 46–50. See also Agde, G., and Winter, A., Influence of Oxidation on the Benzol and Petroleum-Ether Solubility, and on Certain Properties of Bitumens from Bituminous Coal: Brennstoff-Chem., vol. 15, 1934, pp. 67–68; Influence of Oxidation on the Gas Formation and Composition of Constituents of Bituminous Coal: Brennstoff-Chem., vol. 15, 1934, pp. 81–84; Theory of Production of Coherent Coke from Bituminous Coal: Brennstoff-Chem., vol. 15, 1934, pp. 126–129.

[28] See footnote 8.

[29] Bunte, K., and Brückner, Horst, Oxygen Absorption and Aging of Coals at Ordinary Temperatures and the Chemistry of the Sorption of Oxygen: Ztschr. angew. Chem., vol. 47, 1934, pp. 84–86.

[30] Haldane, J. S., and Makgill, R. S., Spontaneous Oxidation of Coal and Other Organic Substances: Coll. Guard., vol. 149, 1934, p. 861.

[31] Magaldi, Francesco, Spontaneous Combustion of Italian Fuels: Ann. chim. applicata, vol. 24, 1934, pp. 3–20; Chem. Abs., vol. 28, 1934, p. 3865.

bustion. The average reducing power of nearly 50 anthracite samples between 900° and 950° was 57 percent, with an initial reaction temperature of 572° C. The average reducing power of five coke samples under the same conditions was 22 percent, with an initial reaction temperature of 715° C.[32]

Analytical and testing methods.—Holmes [33] has reported the results of sampling experiments which showed that serious errors are produced by segregation of pieces of different sizes and densities.

The American Society for Testing Materials has published a pamphlet containing the various methods of testing, definitions, and specifications for coal and coke, as approved by the society.[34] The German Standards Committee has published a similar pamphlet.[35] New methods or modifications have been proposed for determining sulphur,[36] nitrogen,[37] phosphorus,[38] and ash [39] in coal and coke. Fluorine was added to the list [40] of elements found in coal by Lessing;[41] it was collected in the ammonia liquor in a certain gas works where it corroded the porcelain tower fillings. Iodine originating from Ostrava coal was found in the blast-furnace dust at the Witkowitz iron and steel works in Czechoslovakia.[42]

Methods for determining fusion temperatures of coals also have been studied by several investigators.[43] Ternary diagrams have been developed by means of which approximate softening temperature may be predicted from the ash analysis.[44] A chart showing the relation between the chemical composition of slags and their fluidities, data on samples from stations operating slag-tap furnaces, and tests for the disposal of fly ash by returning it to the slag bed have been published by the Bureau of Mines in cooperation with the American Society of Mechanical Engineers.[45]

A simple roll test for determining the grindability of coal,[46] based on the principle of increase of new surface measured in accordance with Rittinger's theory of crushing, has been proposed. Particle-

[32] Keene, W. L., Turner, H. G., and Scott, G. S., Reactivity of Anthracite with Carbon Dioxide: Trans. Am. Inst. Min. and Met. Eng., Coal Division, vol. 108, 1934, pp. 303–323.

[33] Holmes, C. W. H., The Sampling of Coal: Coll. Eng., vol. 11, 1934, pp. 24–27, 40–42, 46, 83–86, 89, 135–138, 188–192, 235–238, 261–264, 278.

[34] American Society for Testing Materials, Standards on Coal and Coke: September 1934, 108 pp.

[35] German Standards Committee, Testing of Fuels: German Standards Publication 3011, 1934, pp. 1–23. Iron and Coal Trades Review, Testing Solid Fuels; Revised German Specifications: Vol. 129, 1934, p. 296.

[36] Raskin, L. D., Simultaneous Determination of Sulphur and Ash in Nonbituminous Coals and Coke by Combustion in a Stream of Oxygen: Zavod., Lab. vol. 3, 1934, pp. 614–616. Kefeli, M. M., and Berliner, E. R., Rapid Determination of Sulphur in Coals, Coke, and Anthracite by Titration with $BaCl_2$ in the Presence of Sodium Rhodizonate: Zavod. Lab., vol. 3, 1934, pp. 201–204; Chem. Abs., vol. 29, 1935, p. 318.

[37] Meldrum, W. B., Melampy, R., and Myers, W. D., Use of Aeration in Kjeldahl Distillations: Ind. and Eng. Chem., anal. ed., vol. 6, 1934, pp. 63–64. Beet, A. E., An Improved Kjeldahl Process for the Determination of Nitrogen in Coal and Coke: Fuel, vol. 13, 1934, pp. 343–345.

[38] British Standards Institution, British Standard Method for the Determination of Phosphorus in Coal and Coke: British Standard Spec. 568, 1934, 9 pp.

[39] Coke-Oven Committee of the Association of Mining Interests of Essen and the Association of Metallurgists of Dusseldorf, Laboratory Instructions of the Coke Oven Committee. 1. Chemical Investigation of Fuel Ashes and Slags: Glückauf, vol. 70, 1934, pp. 511–513.

[40] Briggs, H. Metals in Coal: Coll. Eng., vol. 11, 1934, pp. 303–304, 308. Thilo, E., Results of Analysis of Two Coal Ashes. Ztschr. anorg. allgem. Chem., vol. 218, 1934, pp. 201–209; Chem. Abs., vol. 28, 1934, p. 5960.

[41] Lessing, R., Fluorine in Coal: Fuel, vol. 13, 1934, pp. 347–348.

[42] Queensland Government Mining Journal, Iodine in Blast-Furnace Gas Dust: Vol. 36, 1935, p. 15.

[43] Kosaka, Y., and Toda, H., Studies on the Fusibility of Coal Ash. I. A Method for Determining the Fusibility of Coal Ash in An Oxidizing Atmosphere: Jour. Soc. Chem. Ind. Japan (suppl.), vol. 37, 1934, pp. 98B–101B. II. A Method for Determining the Fusibility of Coal Ash in a Reducing Atmosphere: Jour. Soc. Chem. Ind. Japan, vol. 37, 1934, pp. 188B–189B. Dawe, A. and Falkner, C. W., A Small Electric Furnace for the Determination of the Fusion Temperature of Coal Ash: Fuel, vol. 13, 1934, pp. 230–236. Simek, B. G., Coufalik, F., and Beranek, Z., The Determination and Evaluation of the Melting Point of Ash: Feuerungstech., vol. 22, 1934, pp. 1–6; Chem. Abs., vol. 28, 1934, p. 1839.

[44] Estep, T. G., Seltz, H., Bunker, H. L., and Strickler, H. S., The Effect of Mixing Coals on the Ash-Fusion Temperature of the Mixture: Carnegie Inst. Tech. Min. Met. Inv. Bull. 62, 1934, 47 pp.

[45] Nicholls, P., and Reid, W. T., Slags from Slag-Tap Furnaces and Their Properties: Trans. Am. Soc. Mech. Eng., Paper RP 56-3, vol. 56, 1934, pp. 447–465.

[46] Sloman, Harold J., and Barnhart, Arthur C., The Relative Grindability of Coal: Trans. Am. Soc. Mech. Eng., vol. 56, 1934, pp. 773–779.

size distribution of the finer sizes is determined by the sedimentation-velocity method.

Small-scale laboratory-assay tests[47] for determining the yields of coke, gas, and byproducts of coal have been in general use during the year for studying the suitability[48] of coals for coking and for estimating probable yields to be expected in large-scale[49] operation. The Bureau of Mines has published the results of a comprehensive investigation of the yields and properties of gas, coke, and byproducts obtained in the carbonization of 30 coals and blends of coal carbonized at temperatures from 500° to 1,100° C.[50]

PREPARATION OF COAL

General features.—Competitive conditions and code regulations gave added impetus to the installation of improved equipment for preparing and cleaning coal in 1934. Facilities for mechanical handling of anthracite and bituminous coal underground and the use of methods designed to improve preparation at the face increased. New or improved mining machines suitable for cutting thinner kerfs either horizontally or vertically, with refinements in methods for breaking down the coal, probably resulted in an increased size and a better quality of mine-run coal reaching the surface preparation plants.

The capacity of surface plants for preparing anthracite and bituminous coal by screening methods installed or contracted for during the year was reported to be about 7,800 tons per hour and that for mechanical cleaning equipment about 5,500 tons per hour.[51] New preparation facilities were installed at 69 plants during the year, and 38 of these included units for cleaning part or all of the mine product; most of these involved only additions to existing plants. The new installations of washing and cleaning equipment included wet and dry units, with jigs of the Baum type apparently predominating in number. In addition 2 conical-type separators, 2 jigs, 1 air launder, and 1 air-sand separator were installed.[52] Hand-picking methods were replaced by treatment of coal up to 7 inches in size by jigs and up to 8 inches by cone separators.

The demand for smaller sizes of coal for use in small, automatic stokers increased. According to the United States Census Bureau[53] sales of stokers by 83 manufacturers totaled 21,253 units compared with 14,810 stokers sold in 1933 and 9,571 in 1932. Seventy-eight percent of the sales in 1934 were domestic units, with a capacity of 100 pounds or less of coal per hour.

[47] Selvig, W. A., and Ode, W. H., Determination of Gas, Coke, and Byproducts of Coal—Evaluation of Laboratory Assay Tests: Ind. and Eng. Chem., anal. ed., vol. 7, 1935, pp. 88–93.

[48] Jenkner, A., Kuhlwein, F. L., and Hoffman, E., Laboratory Method of Testing the Suitability of Coals for Coking: Glückauf, vol. 70, 1934, pp. 473–481.

[49] Sladek, Fr., The Course of Carbonization of Bituminous Coal in the Laboratory and Upon Plant Scale: Brennstoff-Chem., vol. 15, 1934, pp. 1–4.

[50] See footnote 24.

[51] Coal Age, Bituminous Preparation Drives for Higher Quality and Greater Efficiency: Vol. 40, 1935, pp. 75–77. Coal Age, New Preparation Facilities: Vol. 40, 1935, p. 77. Hall, R. Dawson, Improved Mining and Cleaning Practice Seen in Coal Industry: Min. and Met., vol. 16, 1935, p. 31. Dana, E. L., Jr., Anthracite Shows Signs of Being Considered a Wasting Asset: Min. and Met., vol. 16, 1935, p. 31. Young, L. E., Use of Mechanical Equipment Spreads in Bituminous Mines: Min. and Met., vol. 16, 1935, pp. 32–34. Nold, H. E., New Uses of Coal Not So Necessary as Better Understanding of Old: Min. and Met., vol. 16, 1935, p. 34. Bird, Byron M., Coal Cleaning Finds Wider Application—New Equipment Developed: Min. and Met., vol. 16, 1935, p. 35.

[52] See footnote 51 and following: Coal Age, Anthracite Companies Explore All Roads to Cost Reduction: Vol. 40, 1935, pp. 57–60. Coal Age, Air-Sand Process Cleans Railroad and Industrial Coal at Chickasaw Mine: Vol. 39, 1934, pp. 342–343, 352. Coal Age, How Naomi Rebuilt Its Tipple: Vol. 39, 1934, pp. 377–379.

[53] Bureau of Census, Mechanical Stokers: December 1934; Coal Age, Stoker Sales Advance Sharply: Vol. 40, 1935, p. 138.

Equipment for crushing coarse coal to meet the demand for smaller sizes and vibrating screens, with and without dedusting units, were installed at a number of preparation plants. In a new-type crusher coarse coal is broken with a minimum production of finer sizes by the application of pressure at selected points with a series of long, sharp-pointed rods or picks.

Flaky, bony material can be eliminated by properly operated tables provided the coal is coarser than 100-mesh; the material finer than 100-mesh is responsible for low table efficiencies.[54] At the Sophia-Jacoba mine, Hückelhoven, Germany, coal sized between 3⅛ and ⅝ inches is treated in a bath of heavy liquid, specific gravity 1.47, made by suspending a mixture of fine barite (barium sulphate) and clay in water. Heating to 35° C. reduces its viscosity and permits rapid settling and a sharp separation of impurities.[55] The average yield by the process approaches float-and-sink yields closely and is about 4 percent higher than that given by jig-washing. The cost is slightly less than jigging.

Dewatering and drying.—A number of washeries installed heat driers, centrifugal driers, and dewatering screens during the year. The No. 11 mine washery, United Electric Coal Cos., Fidelity, Ill., installed vibrator screens to remove through 48-mesh undersize from the ¼-inch feed to centrifugal driers. The heat driers included a type in which a heated current of air is passed down through a bed of coal as it travels forward on a perforated endless conveyor. High-speed, short-stroke, horizontal vibrating screens equipped with wedge wire were used for dewatering washed coal.

Dedusting.—Several additional pneumatic dedusting plants were put in during the year. The contract has been awarded for a new installation at the Champion No. 1 mine, Imperial, Pa., of dedusters of English design, with a capacity for treating 150 tons per hour of through ⅜-inch coal. The separation in the deduster will be made at about 48-mesh. Utilization of the dust produced by such units is still a problem at some plants. A survey at 20 mines in England showed that the dust was used for pulverized-fuel firing for power stations or at the mines, for which it is suitable after further pulverization or mixed with washed small coal and washery sludge for coking or combustion.[56]

Flotation.—Several coal-mining companies continued semicommercial experimentation on froth flotation for cleaning coal sludge. At a washery of the Pittsburg & Midway Coal Mining Co., near Pittsburg, Kans., the process has been applied ingeniously to yield (1) cleaned coal for the market, and (2) cleaned clay tailings for use in supplying the heavy suspension required in the primary cone separator cleaning process. Research at the Northwest Experiment Station of the Bureau of Mines showed that under proper conditions ferrous and ferric sulphates were effective in depressing pyrite in the coal-flotation circuit and that the recleaning of coal froths for reduction of ash content was much more economical than dilution of the original feed suffi-

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[54] Richardson, A. C., Gandrud, B. W., and Musgrove, W. D., Table Cleaning of Fine Coal from the Thompson and Woodstock Beds of the Cahaba Field, Alabama: Rept. of Investigations 3234, Bureau of Mines, 1934, 19 pp.

[55] Gröppel, K., Washing of Bituminous Coal with a Heavy Liquid by the Sophia-Jacoba Process: Glückauf, vol. 70, 1934, pp. 429–435; Chem. Abs., vol. 28, 1934, p. 6976. Colliery Guardian, New Method of Cleaning Coal by Heavy Liquids: Vol. 149, 1934, pp. 199–201.

[56] Holmes, C. W. H., Lindley, G., Slade, A. M. Harrison, and Winspear, A. H., Dedusting of Coal: Symposium held by the Midland Coke-Oven Managers' Assoc., June 1934; Gas World, vol. 101, no. 2613, coking section, 1934, pp. 96–99; Coll. Guard., vol. 148, 1934, pp. 1050–1052, 1100–1102.

ciently to give a cleaned product of the same ash content by a single-pass treatment.[57]

The first commercial installation of the vacuum-flotation process was made at a colliery in England,[58] in which the dust from a pneumatic deduster will be cleaned. Further studies made by the Fuel Research Board in England,[59] showed that the process was not suitable for treatment of coals containing soft fireclay, which disintegrates readily in water, without preliminary desliming to remove the major portion of the clay before treatment; however, in some cases the clay can be flocculated with the aid of size or glue.[60]

"Pressure flotation"[61] without reagent has shown some promise in laboratory-scale experiments; dry coal in air or other gas is subjected to 20 to 60 pounds per square inch pressure, water is added, and the pressure is released.

Flocculation and settlement of solids in washery water.—In a few instances lime has been added to the water in coal washeries in the United States to increase the rate of clarification of wash water, to prevent the loss of fine material, and to obviate the possibility of stream pollution. The Pacific Coast Coal Co., in Washington, recently has adopted this procedure at another one of its mines after obtaining satisfactory results in full-scale trials. An increased recovery of fine coal has resulted.

Further study and use of various flocculating agents have continued abroad.[62] Small-scale trials of a new filter, in which the filtering medium consisted of a layer of canvas stretched on porous rubber have proven highly successful. Raybould [63] recommends conditioning the washery water with electrolytes to reduce the sliming of clay particles and flocculation of the residual colloids to promote rapid settling in the cone. He states that the cost of reagents for treatment by the lime-starch-caustic soda process is about 21 cents per 1,000 gallons, or 16 cents per ton of dry recovered solids.

The Fuel Research Board, England,[64] in experimental work using gelatin in the form of a glue as a flocculating agent found that of 3 different washery slurries treated 2 showed an increased rate of settlement on the addition of small quantities of gelatin but with the third the addition was disadvantageous. These results show that the best flocculating agent must be determined at each washery. After 12 and 24 hours of operation [65] of a semilarge-scale experiment with glue in a continuous washery circuit the flocculated slurry contained 0.1 and 1 percent solids. Flocculated slurry forms a porous filter cake

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57 Yancey, H. F., and Taylor, J. A., Froth Flotation of Coal; Sulphur and Ash Reduction: Rept. of Investigations 3263, Bureau of Mines, 1935, 20 pp.

58 Colliery Guardian, Coal Cleaning. Extensive Installation Planned for the Wallsend and Hebburn Coal Co., Ltd.: Vol. 149, 1934, p. 104.

59 Department of Scientific and Industrial Research, Report of the Fuel Research Board for the Year Ended 31st March, 1933: H. M. S. Office, p. 44.

60 Department of Scientific and Industrial Research, work cited, p. 41.

61 See footnote 60.

62 The Institution of Mining Engineers, Utilization of Coal Committee, The Clarification of Washery Water: Mem. 15, 1934, 5 pp.; Coll. Guard., vol. 149, 1934, pp. 196 and 197. See also Peterson, W., Works Tests on Clarification of Slime Water from Bituminous-Coal Washeries: Glückauf, vol. 70, 1934, pp. 125–131. Engineering, The Henry Process for the Clarification of Polluted Water: Vol. 138, 1934, pp. 213–215, 293, 295.

63 Raybould, W. E., The Conditioning of Washery Water, Flocculation: Trans. Inst. Mining Engr. (London), vol. 88, 1934–35, pp. 192–229; Coll. Guard., vol. 149, 1934, pp. 1094–1096, 1140–1141, 1187–1190; Iron and Coal Trades Rev., vol. 129, 1934, pp. 939, 972, 1013, 1015.

64 Department of Scientific and Industrial Research, Report of the Fuel Research Board for the Year Ended 31st March 1933: H. M. S. Office, pp. 56–57.

65 Davies, D. T., and Wilkins, E. T., The Flocculation of Slurries. The Continuous Clarification of a Coal Washery Circuit with Glue: Fuel, vol. 14, 1935, pp. 51–55.

which promotes high capacity and facilitates removal of the cake from the filter fabric.[66]

The Fuel Research Board has continued its studies of the settlement of washery slurry without the addition of flocculating agents. Using a tank of rectangular section with the feed admitted at one end they were able to reduce the size of the tank to less than one fifth by installing a system of inclined baffles. Moreover, by using 4 sludge hoppers instead of 1 they were able to obtain rough classification by size into four products.[67]

Dust-prevention treatment and dyeing.—Additional sprays to be applied to coal and coke for prevention of dustiness, for providing pleasant odors, and for identifying trade products have appeared.[68] Meredith considers that oil emulsified with sodium resinate is the best dust preventive.[69] Coryell has described the coke-dust-proofing equipment of the New York & Queens Gas Co. at the Flushing coke station.[70]

BRIQUETTING

The marketing of coal and of sawdust briquets in paper-wrapped packages and cartons is attracting attention in some sections of the United States. A number of small coal-briquetting plants are now operating in distribution centers somewhat remote from coal-mining areas. The briquets are made in cubical shapes with a plunger-type press using ¾- or ½-inch screenings and about 1 percent binder.[71] A machine for wrapping the briquets ordinarily is installed as a part of the equipment. Construction of a plant to make coal briquets in 3-inch cubes was started late in the year at Paris, Ark.[72] Another plant at Renton, Wash., is making briquets of coal and of coal-tar coke in the shape of common brick. Two timber companies, one in Washington and the other in Idaho, are compressing kiln-dried Douglas fir and white-pine sawdust and shavings into 7- to 8-pound cylindrical log-shaped briquets and marketing them in paper cartons containing 6 to 12 briquets.

The manufacture of briquets without binder has been receiving much attention.[73] The Rtanj Collieries in Yugoslavia is using the Apfelbeck briquetting press for this purpose.[74]

A rather novel method for mixing petroleum pitch with coal to be briquetted is used at the Petrosani mines in Rumania. The liquefied pitch is atomized by pumping it under pressure through a fine orifice

[66] Department of Scientific and Industrial Research, work cited, pp. 45–46.

[67] Department of Scientific and Industrial Research, work cited, pp. 54–56.

[68] Powell, Alfred R. (to Koppers Co.), Process of Treating Coke: U. S. Patent 1989526, Jan. 29, 1935. (Uses a half gallon of a light mineral oil of high gravity, high flash point and high boiling point per ton of coke.) Doherty, Joseph D. (to Koppers Co.), Treated Coke and Process of Treating the Same: U. S. Patent 1932815, Oct. 31, 1933. (Uses sulphite screenings, dye, rosin size, and calcium chloride.) Cunningham, Noel, and Peck, C. L. (to Champion Fibre Co.), Process of Treating Coal and Product: U. S. Patent 1988999, Jan. 22, 1935. (Uses "alkaline black liquor byproduct," water, and fuel oil.) Snell, Foster D., and O'Conner, Alfred H. P., Color Composition: U. S. Patent 1991872, Feb. 19, 1935. (Uses hide glue with a water-insoluble coloring matter together with a plasticizing wax such as beeswax or paraffin and formaldehyde as a preservative. Metal soaps, etc., also may be used.) Holst, Wm. A., Jr., Colored Coal and Producing the Same: U. S. Patent 1971683, Aug. 28, 1934. (Uses an aqueous suspension of a pigment and sodium stearate which is converted to the free soap acid by acidulated water after application.)

[69] Meredith, H. J., Dustproofing Coke: Gas-Age Record, vol. 73, 1934, pp. 533–536. See also Petroleum Times, Oil for Dustproofing Coke, vol. 32, 1934, p. 666.

[70] Coryell, R. L., The Dust-Proofing of Coke: Gas Age-Record, vol. 73, 1934, pp. 611–612.

[71] Eberling, C. M., "Packaged Fuel" Opens New Market for Use of Screenings: Coal-Heat, vol. 25, 1934, no. 4, p. 42.

[72] Coal Age, Briquetting Moves Further into the Limelight: Vol. 40, 1935, p. 78.

[73] Thau, A., Bituminous Coal Briquetting Without Binder: Glückauf, vol. 70, 1934, pp. 376–378; Briquetting Coal Without a Binder: Coll. Guard., vol. 149, 1934, pp. 333–335; Briquetting Coal Without a Binding Medium: Fuel Econ., 1934, pp. 359–361.

[74] Holik, J., Coal Briquetting Without a Binder: Glückauf, vol. 70, 1934, pp. 385–393.

into a revolving horizontal mixing crum containing the coal.[75] It is claimed that only 5 percent of binder is required with this process compared with 8 percent with the usual methods. The strength of the briquets is about 30 percent greater than of those in which coal-tar pitch is used as a binder.

COMBUSTION

Sales of domestic stokers have continued to increase. The sprinkling-type overfeed stoker which has proved successful with large boilers has been adapted to domestic use. Several stoker companies have brought out pulverizer units suitable for small boilers. The Anthracite Institute Laboratory has developed a new horizontal-combustion magazine-type heater which has no combustion space above the fuel bed or air openings in the solid grate underneath.[76] Advantages claimed are no clinkering, less than 5 percent combustible in the ash, and usually more than 16 percent CO_2 in the flue gas. The furnace requires no blower and but little attention.

Mayers has reviewed [77] the theory of combustion of carbon and has measured the rate of reduction of carbon dioxide.[78]

Installation of Cottrell precipitators for the removal of fly ash at the new Buzzards Point plant of the Potomac Electric Power Co., Washington, D. C., has given a clear stack at all times when the precipitator was in operation.[79] Means for removal of sulphur dioxide, smoke, and dust has been of particular interest in London, England. A process for removing the sulphur from flue gas has been installed at the Battersea power station. Recently the Imperial Chemical Industries has developed to the pilot-plant stage a wet-lime washing process which has no effluent and therefore has a wide application.[80]

Interest in colloidal fuels[81] continues, but practical use has been confined to demonstration tests.[82]

COMPLETE GASIFICATION

Terres [83] and associates in Germany, on the basis of a critical review of the literature and new experimental work on water-gas reactions, find that the reactivity of graphite, lampblack, bituminous-coal coke and semicoke, wood charcoal, and brown-coal coke and semicoke increase in the order given. The speed of the water-gas reaction with North Dakota lignite is governed chiefly by the velocity of the chemical

[75] Berthelot, Charles, Consumption of Pitch in the Manufacture of Briquetted Fuels: Genie civil, vol. 105, 1934, pp. 127–130.

[76] Johnson, Allen J., A New Principle of Furnace Design for Anthracite: Ind. and Eng. Chem., vol. 27, 1935, pp. 944–948.

[77] Mayers, Martin A., The Combustion of Carbon: Chem. Reviews, vol. 14, 1934, pp. 31–53; Mechanism of Combustion of Carbon: Am. Inst. Min. and Met. Eng. Tech. Pub. 575, 1934, 17 pp.

[78] Mayers, Martin A., The Rate of Reduction of Carbon Dioxide by Graphite: Jour. Am. Chem. Soc., vol. 56, 1934, pp. 70–76.

[79] Hopper, Thomas B., Electrostatic Precipitation of Fly-Ash: Proc. Am. Gas Assoc., 1934, p. 911.

[80] Pearson, J. L., Nonhebel, G., and Ulander, P. H. N., Removal of Smoke and Acid Constituents from Flue Gases by a Noneffluent Water Process: Jour. Inst. Fuel, vol. 8, 1935, pp. 119–156, 183–199; Coll. Guard., vol. 150, 1935, p. 116.

[81] Brownlie, David, Colloidal Fuel—Various Principles and Processes Reviewed: Iron and Coal Trades Rev., 1934, pp. 671–672. Radiochemisches Forschungsinstitut, G. m. b. H., Composite Fuels: British Patent 406067, Feb. 22, 1934; Colloidal Fuel: British Patent 417352, Oct. 3, 1934. (Suspensions stabilized by an oleate, palmitate, or stearate, paraffin, or other wax.) Department Scientific and Industrial Research, Report of the Fuel Research Board for the Year Ended 31st March, 1934: H. M. S. Office, pp. 125–129.

[82] Wigginton, R., Notes on Recent Developments in Fuel Technology, Colloidal Fuel: Fuel, vol. 14, 1935, p. 61.

[83] Terres, E., Patscheke, G., Hofmann, H., Kovacs, St., and Löhr, O., The Formation of Water Gas and the Behavior of Brown Coal and Bituminous-Coal Cokes and Semicokes in Water-Gas Generation: Gas u. Wasserfach, vol. 77, 1934, pp. 585–587, 628–636, 650–654, 666–669, 681–684, 703–706.

reaction rather than by diffusion.[84] However, the rates of gasification may be increased by the use of oxygen and fine sizes of solid fuel in a bed maintained "in teeter" by an upward current of water gas produced in the same apparatus.[85] Portable producer-gas plants for busses, tractors, and trucks continue to interest European countries.[86] Tests show 77.5 percent savings [87] in fuel cost over ordinary gasoline; 1.25 kg of charcoal is equivalent to 1 liter of gasoline [88] and superior to wood gas,[89] although the latter has been used satisfactorily.[90]

HIGH-TEMPERATURE CARBONIZATION

The carbonization of coal by electrical heating, which was tested on a small scale at Lecco, Italy, in 1910 and recently in a 30-ton experimental retort by the Detroit Edison Co.,[91] has been repeated on a small scale (700 pounds) at Baden, Switzerland, and Reggio, Italy. The current required for continuous operation was 440 kilowatt-hours per net ton of coal.[92] Assuming that the carbonization of a coal with 3-percent moisture requires 650 B. t. u. per pound Foxwell [93] calculates the electrical energy required as 427 kilowatt-hours per ton of coal; hence, cheap off-peak power would be required, such as may become available in the Tennessee Valley.

Although experiments of the type were proposed years ago by Sir William Ramsey, Soviet Russia has reported the first tests ever undertaken to gasify coal underground. Leakage and lack of control of the process lead to poor quality of gas and incomplete combustion of the coal. Further experiments will be made in other districts.[94]

New coke plants.—The continued depression in the iron and steel industry and the increased supply of natural gas have not favored the construction of new coking plants, the only American projects being (1) a contract let by the Public Service Co. at Camden, N. J., for a 37-oven battery of improved Becker ovens and (2) a battery of 10 Knowles ovens [95] built for the Radiant Fuel Corporation at West Frankfort, Ill. The Becker ovens will have an average width of 16 inches, coal line 8 feet 7 inches, and length 31 feet 3½ inches. The Knowles ovens are 7½ feet wide, 30 feet long, and about 4 feet high to the center of the arched top. The coal charge is 10 inches deep

[84] Brewer, R. E., and Reyerson, L. H., Production of High-Hydrogen Water Gas from Younger Coal Cokes. Effect of Carbon Dioxide upon Cokes: Ind. and Eng. Chem., vol. 26, 1934, pp. 1002–1008.

[85] I. G. Farbenindustrie Aktiengesellschaft, Germany, Improvements in and Apparatus for the Gasification of Fine Ground Fuels: British Patent 421356, Dec. 19, 1934. See also Hillebrand, H., Continuous Water-Gas Generation: U. S. Patent 1913237, June 6, 1933.

[86] Isendahl, Walter, New German Gas Generators for Motor Vehicles: Automobiltech. Ztschr., vol. 37, 1934, pp. 294–300; The Koela Producer-Gas Vehicle, Comm. Motor, 1934, p. 629.

[87] Russell, J., Portable Producer Gas Plants: World Petroleum Congress, London, 1933, Proc., vol. 2, pp. 769–773.

[88] Neue Kraft Zeitung, The Wisco Autogas Generator: 1934, p. 373.

[89] Kühne, G., Charcoal Gas as a Fuel for Power-Driven Vehicles: Ztschr. Ver. Deut. Ing., vol. 78, 1934, pp. 1241–1242; Chem. Abs., vol. 29, 1935, 908.

[90] Lentze, Goswin, Motor-Bus Operation with Wood Gas. Results of Practical Operation: Automobiltech. Ztschr., vol. 37, 1934, pp. 289–293; Chem. Abs., vol. 29, 1935, p. 908. See also news ed., Ind. and Eng. Chem., vol. 13, 1934, p. 7.

[91] Walker, H. S., The Carbonization of Coal with Electricity: Gas-Age Record, vol. 70, 1932, pp. 27–30; Stevens, Harold, Method of Processing Coal: U. S. Patent 1993756, Mar. 12, 1935.

[92] Bohm, M., The Use of Electricity in the Manufacture of Town Gas: Gas World, vol, 101, 1934, p. 383. Electric Furnaces for City Gas Production: Gas Age Record, vol. 75, 1935, pp. 115–116, 118. Kirchrath, H., Electric Heating in the Industry and Chemistry of Fuels: Elektrowärme, vol. 5, 1935, pp. 14–15; Chem. Abs., vol. 29, 1935, 1607–1608.

[93] Foxwell, G. E., The Electrical Carbonization of Coal. Is It a Business Proposition: Gas Eng., vol. 51, 1934, pp. 457–459.

[94] Kirichenko, I. P., First Results in the Field of Underground Gasification: Ugol (U. S. S. R.), vol. 101, 1934, pp. 90–101; Fuel, vol. 13, 1934, pp. 318–319; Coll. Guard., vol. 150, 1935, p. 502; Chem. Abs., vol. 29, 1935, p. 320.

[95] Coal Age, Widens Market for No. 5 Illinois Screenings by Turning Fines into Domestic Coke: Vol. 39, 1934, pp. 421–423.

and lies in a horizontal layer heated from beneath through a silica or carborundum floor. The special advantages claimed for this type of oven are low investment cost in small units suitable for installation at coal mines and ability to make coke from poorly coking coals, from mixtures of coal and tar or oil, and from pitch and petroleum residues. A battery of Knowles ovens has been constructed at the Corby Iron Works near Kettering, Northamptonshire, England, for the production of metallurgical coke from mixtures of pulverized noncoking coal and heavy tar or petroleum residues.[96]

Increasing benzol yield.—Foreign demand for benzol has maintained interest in coke-oven modifications which favor increased yields of light oil. The Goldschmidt top channel, which increases the yield of benzol about 10 percent has been adapted to some 200 ovens in Germany,[97] and also in the new battery of "Kogog" ovens installed at the Cargo Fleet Iron Works of the South Durham Steel & Iron Co., Ltd., in England.

Recent investigations [98] show that the pyrolysis of benzol proceeds simultaneously with its production by the pyrolysis of other higher hydrocarbons. Under the conditions of most coke ovens the increased yields of benzol by the Goldschmidt process may be due to increased rather than decreased cracking. These findings agree with those of Davis and Auvil [99] of the Bureau of Mines, who observed an increase in the yield of light oil resulting from increase in time of exposure of the gases and vapors to a temperature of 900° C. in the free space above the charge in the Bureau of Mines-American Gas Association test retort.

The growing demand for motor benzol in England has led to a number of new and improved light-oil installations at horizontal and vertical retort plants.[1] Although light-oil removal reduced the calorific value of the gas about 26 B. t. u. per cubic foot at the North Shields Station [2] this loss was more than compensated by the value of the recovered benzol and by the removal of the organic sulphur and naphthalene [3] from the gas.

The Instill process for refining light oil has been simplified and improved with respect to removal of thiophene and reagents required.[4]

Purification of gas.—Gas purification by sulphur-recovery methods has continued to make progress. A new type of pressure thionizer has been installed at the "Thylox" purification plant of the Laclede Gas Light Co., St. Louis, Mo., and a large Thylox recovery plant for

[96] Fisher, A., Processing of Solid and Liquid Hydrocarbons in the Coal, Oil, and Gas Industries, with reference to Developments at Corby: Jour. Inst. Fuel, 1935; Coll. Guard., vol. 150, 1935, pp. 657–660. Thau, A., The Coal in Oil Distillation and Carbonization Process: Glückauf, vol. 71, 1935, pp. 10–15.

[97] Thau, A., Increasing the Yield of Benzene from Coke Ovens: Brennstoff-Chem., vol. 15, 1934, pp. 41–45; Practical Means to Increase the Yield of Benzol on Coke Ovens: Gas World, coking section, vol. 101, 1934, pp. 83–85, 88.

[98] Nettlerbusch, L., and Jenkner, A., Methods of Increasing the Yield of Benzene in Coke-Oven Operation: Glückauf, vol. 70, 1934, pp. 1165–1172. Krueger, H., Hofmeister, B., and Krebs, E., Fundamental Considerations on the Question of Top Channels: Glückauf, vol. 71, 1935, pp. 221–230. See also Concordia Bergbau Aktiengesellschaft, Process for Degasifying Solid Fuels in Intermittently Operated Chamber Ovens: British Patent 419125, Nov. 6, 1934.

[99] Davis, J. D., and Auvil, H. S., High-Temperature Carbonization of Coal—Effect of Free Space on the Yield and Properties of Gases and Tars: Ind. and Eng. Chem., vol. 27, 1935, pp. 459–461.

[1] Gas Journal, Technical Signpost: Vol. 206, June 6, 1934, pp. 650–652.

[2] Wikner, S. W. A., and Richardson, B., Aspects of Benzol Recovery and Refining: Gas Jour., vol. 206, 1934, pp. 559–567.

[3] Chester, C. H., The Recovery of Benzole from Vertical Retort Gas; Experience at Swindon: Gas Jour., vol. 205, 1934, pp. 551–556. Davison, H. G., Benzene Washing of Coal Gas From Horizontal Retorts: Gas Jour., vol. 205, 1934, pp. 625–626.

[4] The Gas World, Recent Developments in the Refining of Motor Benzol and Similar Fuels. The Instill Process: Vol. 102, 1935, pp. 15–17. The Instill Process—A Comparison Between the Instill Process and Acid Washing Processes: Vol. 102, 1935, pp. 41–45.

purifying blue water gas has been installed by the Du Pont Co. at Belle, W. Va. A pilot plant of the Rostin process for catalytically purifying manufactured gas and light oil from sulphur [5] and also catalytically converting CO to CO_2 has given satisfactory results at the Tegel plant of the Berlin Gas Works.[6]

The dehydration of gas by glycerin at the Luton Gas Works [7] in England reduced materially the formation of rust, and the stoppages caused by it.

Fulweiler and associates found that nitric oxide must be removed entirely to prevent formation of gum in manufactured gas; it can be done by special working of iron oxide purifiers.[8] The gum particles, when first formed, probably are of molecular size. They coalesce and remain dispersed in the gas until the particles grow to about 1.5 μ when they deposit on the walls of the pipes and on the burner orifices; 0.3 mg of gum plus the associated dirt is enough to stop a pilot-light orifice.[9] A survey of the British gas industry showed that 50 percent of the companies experienced gum trouble.[10]

The Metallgesellschaft A. G. of Frankfurt-am-Main has developed a process for manufacturing sulphuric acid from the devil gases (20 to 30 percent H_2S) of the ammonia saturator, equal to one-fifth of the daily acid requirement for sulphate manufacture.[11]

Tar recovery and utilization.—Electrostatic tar precipitation has become standard practice at most new coke-oven plants in England.[12] Power consumption is 1 to 1.5 kilowatts per 100,000 cubic feet of gas. The capital cost is about $9,600. The efficiency is over 99 percent, and the tar content of the crude gas is reduced to about 1 grain per cubic foot.

The Institution of Gas Engineers [13] finds a great diversity of opinion on the nature of tars most suitable for use in Diesel engines and on the degree of satisfaction realized by users. Fuel cost is considerably less than that of gasoline, but more skillful attention is required. In general, tar-oil fuel has been employed only for running, gasoline being used for starting up and idling. In stationary engines of the spark-ignition type results are much more promising. Tar oils are inherently unsuitable for use in the standard types of compression-ignition engines. The exhaust gases contain very little carbon monoxide, but complaints have been made of a creosote odor. Engine tests are being carried out by Gewerkschaft Matthias Stinnes in the hope of finding a suitable catalyst for use in front of the combustion chamber, to reduce the ignition temperature of the tar oils.

Gas utilization.—The municipal gas works at Hameln near Hanover, Germany, has installed the first and only plant in the world for rendering coal gas nonpoisonous by the catalytic conversion of the carbon

[5] Thau, A., The Desulphurization of Coal Gas: Chem.-Ztg., vol. 59, 1935, pp. 193–195.
[6] Thau, A., The Rostin Process for Removing Sulphur from Gas and Increasing the Value of Coal Gas and Benzol: Glückauf, vol. 71, 1935, pp. 298–304.
[7] Knowles, A. F. H., and Summerson, R., The Glycerin Gas-Dehydration Process: Gas Jour., vol. 205, 1934, pp. 809–810.
[8] Fulweiler, W. H., The Gum Problem. Recent Developments: Gas Jour., vol. 206, 1934, pp. 207–210.
[9] Jordan, C. W., Ward, A. L., and Fulweiler, W. H., Gum Deposits in Gas Distribution Systems; Vapor-Phase Gum: Ind. and Eng. Chem., vol. 26, 1934, pp. 947–955, 1028–1038.
[10] Wood, J. W., and Parrish, E., Discussion of 34th Report of the Joint Research Committee of the Institution of Gas Engineers and Leeds University: Gas Jour., vol. 208, 1934, pp. 527–530.
[11] Schumacher, —., A New Way for the Production of Sulphuric Acid in the Manufacture of Sulphate of Ammonia: Gas u. Wasserfach, vol. 77, 1934, pp. 337–339; Gas Jour., vol. 207, 1934, p. 26.
[12] Institution of Mining Engineers, Utilization of Coal Committee, The Electrostatic Detarring of Coke-Oven Gas: Mem. 17, February 1935.
[13] Spiers, H. M., Smith, E. W., Report on the Use of Coal-Tar Oils in Internal-Combustion Engines: Coll. Guard., vol. 149, 1934, pp. 546–547; Coal-Tar Oils for Internal-Combustion Engines: Fuel Econ., vol. 10, 1934, pp. 627–629.

monoxide to carbon dioxide and hydrogen, using steam at 400° C. Other beneficial effects are reduction of organic sulphur to 0.5 grain per 100 cubic feet, hydrogenation of the naphthalene to tetralin, and quantitative removal of tar fog and oxygen. The treatment cost is estimated at about 3 cents per 1,000 cubic feet.[14]

Interest in the use of compressed gas and volatile hydrocarbons has spread from England [15] to France, Germany,[16] and South Africa.[17] Thirty-one gas-driven vehicles, mainly busses, trucks, and tractors, were operating in France in 1934,[18] and new compressing stations were installed in Lyons [19] and Cambria.[20] The technical problems in the use of coal gas for motor transport have been solved;[21] 250 cubic feet of 500-B. t. u. gas gives mileage equivalent to an imperial gallon of gasoline.

Properties of coke.—The South Metropolitan Gas Co. of London has published its investigations over a period of years on the evaluation of the burning properties of high- and low-temperature cokes in domestic fires by means of laboratory ignition and reactivity tests.[22] The ignition temperatures of cokes increased from 470° to 626° C. as the carbonizing temperature was increased from 650° to 900° C. The combustibility, reactivity, and electrical resistivity decrease with the carbonization temperature, the change being greatest at about 700° C. It is concluded that to obtain a smokeless solid fuel, readily ignitible and freely burning in the ordinary domestic grate, the coal must be carbonized below 700° C. However, Mitchell reports obtaining easily ignitible high-temperature coke in horizontal-retort practice by using suitable blends of coking and noncoking coals.[23]

The Midland [24] and Northern [25] Coke Research Committees of England have continued their studies of the effect of blending coals on the strength and combustibility of cokes made in an experimental oven. Mott [26] reports that as much as 30 percent of durain (equivalent to our American splint coal), which usually is poorly coking, may be blended with bright coal and yet obtain a satisfactory coke, provided the charge is well mixed and crushed all through a ¼-inch and 90 percent through an ⅛-inch sieve. That the addition of up to 8 percent of pulverized fusain or coke dust improves the quality of coke from highly fusible coals [27] has been confirmed in full-scale oven tests at Clairton, Pa. The best results were obtained with 6 percent of —20-mesh coke dust.[28]

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[14] Gerdes, Hans Christian, Detoxification of Gas at Hameln: Gas u. Wasserfach, vol. 77, 1934, p. 707; vol. 78, 1935, pp. 86–87. Plant for Rendering Coal Gas Nonpoisonous: Gas World, vol. 102, 1935, p. 257.

[15] Halliwell, F. B., Experiences with High-Pressure Gas for Road Transport: Gas Jour., vol. 206, 1934, pp. 39–40, 467–469. The Future of Gas Locomotion: Gas World, vol. 101, 1934, pp. 80–81. Pirie, H. L., Compressed Gas for Motor Transport: Iron and Coal Trades Rev., vol. 129, 1934, p. 830. Walter, C. M., The Industrial Application of Town's Gas with Special Reference to its Use as a Substitute for Petrol for the Running of Commercial Vehicles: Chem. and Ind., vol. 53, 1934, pp. 518–526.

[16] Brennerei Zeitug, Gas as a Fuel for Automobiles: Vol. 51, 1934, pp. 47–48.

[17] Pollack, J. J., Local Use of Compressed Gas for Vehicle Operation: Jour. South Africa Inst. Eng., vol. 33, 1934, pp. 109–117.

[18] Gas Times, vol. 2, 1935, p. 36.

[19] Gas Journal, Gas for Motor-Vehicle Propulsion in France: Vol. 206, 1934, p. 315.

[20] Gas Times, vol. 2, 1935, p. 43.

[21] National Gas Council of Great Britain and Ireland, Compressed Gas for Motor Transport: Coll. Guard., vol. 148, 1934, pp. 1103–1104.

[22] Chemical Department, South Metropolitan Gas Co., The Solid Products of the Carbonization of Coal: London, 1934, 123 pp.

[23] Mitchell, J. K., Coke Production in Horizontal Practice: Gas World, vol. 100, 1934, pp. 373–374; Gas Jour., vol. 206, 1934, pp. 96–97.

[24] Midland Coke Research Committee, Report of Progress during 1934: Fuel, vol. 14, 1935, pp. 117–120.

[25] Northern Coke Research Committee, Annual Report. Investigations into the Combustible Properties of Coke: Gas World, vol. 101, coking section, 1934, pp. 74–75.

[26] Mott, R. A., Studies in Coke Formation. XII. The Coking Properties of Durain: Fuel, vol. 13, 1934, pp. 356–365.

[27] Mott, R. A., and Wheeler, R. V., Improving the Quality of Coke: Fuel, vol. 13, 1934, pp. 237–239.

[28] Seyler, H. W., The Effect of —48-Mesh Coal on the Quality of Coke Produced in Byproduct Coke Ovens: Coal Division, Am. Min. Cong., Yearbook on Coal-Mine Mechanization, 1933, pp. 179–184.

The cokes made in narrow ovens were darker, smaller, and more uniform in size than those from wide ovens, but there was no difference in the shatter indexes or combustibility of the coke.[29] Experiments on the influence of grain size and moisture on the bulk density of coke-oven charges showed that blends of three different grain sizes gave higher bulk densities than mixtures of two sizes.[30] Compression of the charge due to dropping the coal 11 feet materially increased the density of charge.[31]

At Leeds University the reactivity of coke to carbon dioxide was increased on carrying the temperature up to 1,500° C., although there was but little increase in the case of petroleum coke and retort carbon.[32]

LOW-TEMPERATURE CARBONIZATION

Foreign developments.—Announcement [33] of a 3-percent dividend by the Low-Temperature Carbonization, Ltd., and the addition [34] of 72 retorts (making 288 in all) at the Doncaster Coalite plant indicates progress in establishing a commercial low-temperature-carbonization industry in England.[35] The three English plants at Doncaster, Barugh, and the South Metropolitan Gas Co. have a total of 628 retorts with a total capacity of 370,000 gross tons of coal per annum. A Coalite plant was started at Lens, France, in July, and other plants are proposed at Lievin and at Bethune. Other British processes remain in the experimental stage.[36] Illingworth has operated at Pontypridd, an 8-ton per day oven of improved design which can be used for swelling or noncaking coals.[37]

The official report of tests[38] by the Fuel Research Station on the L. and N. process shows that an internally heated type of rotary retort produces considerable dust which contaminates the tar and gas. When operated at the stated capacity of the retort (100 tons of coal per day) the tar was not entirely eliminated from the coke, which still retained 19.1 percent volatile matter.

The distillation of mixtures of coal and oil, as carried out at high temperatures in the Knowles ovens at Corby, also is being tried under conditions of low-temperature carbonization in the Cannock process [39] at Cannock Chase, England. Powdered coal mixed with an equal quantity of oil (petroleum or tar oils from the process), 8 percent of

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[29] Marson, C. B., and Briscoe, H. V. A., Influence of Oven Width on Coking of Coals: Blast Furnace and Steel Plant, vol. 23, 1935, pp. 129–131, 188–192.

[30] Staeckel, W., and Radt, W. P., Effect of Grain Size on the Bulk Density of Coking Coal: Fuel, vol. 13, 1934, pp. 282–285, 311–313.

[31] Dummett, G. A., and Greenfield, G. J., Variation of Bulk Density of Coal and its Bearing on Coke-Oven Operation: Colliery Guardian, vol. 148, 1934, pp. 674–677, 722–724.

[32] Blakeley, T. H., and Cobb, J. W., The Reactivities to Carbon Dioxide of Cokes and Other Forms of Carbon at High Temperatures: Gas Jour., vol. 208, 1934, pp. 351–353; Gas World, vol. 101, 1934, pp. 452–455.

[33] Institution of Mining Engineers, Utilization of Coal Committee, Summary of Progress 4: Dec. 31, 1934, pp. 3–4.

[34] Iron and Coal Trades Review, Extension to the Works of Doncaster Coalite, Ltd.; Progress of the Low Temperature Process: Vol. 129, 1934, p. 1017. Petroleum Times, The Askern Coal-Oil Plant: Vol. 32, 1934, pp. 683–684. Colliery Guardian, Low-Temperature Carbonization, Ltd.: Vol. 148, 1934, pp. 940, 983; Low-Temperature Carbonization, Ltd. Opening of Extension to Askern Plant: Vol. 148, 1934, p. 1149; Gas World, The Chemical Engineering Aspect of Low-Temperature Carbonization: Vol. 101, 1934, p. 593.

[35] Roberts, John, Smokeless Fuel and Its Manufacture: Fuel Econ., vol. 9, 1934, pp. 450, 495–498; Static and Rotary Low-Temperature Processes: Vol. 9, 1934, pp. 427–428.

[36] Kroupa, G., New Process of Low-Temperature Carbonization: Petroleum, vol. 30, 1934, pp. 5–7; The Thermax Low-Temperature Carbonization Process, pp. 1–2. Ihlder, H., German Retort for the Low-Temperature Distillation of Coal in England: Oel u. Kohle, vol. 2, 1934, pp. 249–251.

[37] Engineering, Notes from South Wales—Carbonization Process: Vol. 138, 1934, p. 65. Iron and Coal Trades Rev., vol. 129, 1934, p. 918; Illingworth Low-Temperature Process: Vol. 130, 1935, p. 27.

[38] Department of Scientific and Industrial Research, Report of Test by the Director of Fuel Research on the Plant of the British Coal Distillation Co., Ltd., at Newbold, Leicestershire, 1935: H. M. S. Office, London, 29 pp.

[39] Brocklebank, E. W., and Mitford, W. B., Improvements in or Relating to the Distillation of Solid Carbonaceous Material Mixed with Oil: British Patent 421556, Dec. 24, 1934.

which consists of industrial creosote, is treated in a revolving retort 5 feet in diameter and 50 feet long, externally heated to 600° C. The yields from 1 long ton of coal plus 1 long ton of oil, as reported from tests by Dr. C. H. Lander, were 15.3 imperial gallons of refined motor spirit and 15.6 cwt. of smokeless fuel which required briquetting into lump form and subsequent baking before selling for domestic fuel.[40]

In France the annual production of semicoke (not including so-called "artificial anthracite") is approximately 180,000 long tons per annum.[41] This production is divided equally between the medium-temperature coke known as "Carbolux" made at the Mines de Bruay [42] and low-temperature coke made at the Mines de Courrières by the Illingworth process and various other processes at mines and gas plants. Approximately 270,000 tons of artificial anthracite (carbonized briquets) were produced in 1934 by the Trent process at Somain [43] and by the process used at the Mines de Noeux.

Medium-temperature cokes made at temperatures of 650° to 850° C. in the Woodall-Duckham chamber ovens of the Fuel Research Station combined high apparent density and considerable resistance to shatter and abrasion with ease of ignition and reasonably high combustibility.[44] These advantages of medium-temperature coke are confirmed by Bureau of Mines [45] tests of cokes made at various temperatures from 30 American coals. Medium-temperature carbonization of bituminous coal is being developed further in Germany through the installation of another H. Koppers plant and a new modification of the intermittent vertical chamber oven of the Didier-Werke A. G.[46]

No low-temperature plants for carbonizing bituminous coal are operating commercially in Germany, but the Lurgi Co. is now constructing plants for the low-temperature carbonization of brown coal and brown-coal briquets. At the Saar mines 13 to 14 percent of low-temperature coke made by the Salerni process, blended with high-volatile coals, improves the physical properties of the coke and is economically feasible provided a suitable market can be developed for the low-temperature tar.[47]

Several new low-temperature carbonization plants are under construction in Japan as a result of a Government subsidy for a 7-year period to all plants treating not less than 100,000 tons of coal per annum.[48]

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40 Iron and Coal Trades Review, The Cannock Process of Coal Distillation. A New Low-Temperature Project: Vol. 129, 1934, p. 587; Colliery Guardian, vol. 149, 1934, pp. 765–766. Gas Journal, The Application of Waste-Heat Boilers in Carbonizing Plants: Oct. 24, 1934, p. 898.

41 Berthelot, Charles, The Development of Low-Temperature Carbonization and the Manufacture of Synthetic Motor Fuel in France, Germany, and England: Génie civil, Apr. 13, 1935, p. 20.

42 Pamart, Charles, The Production of the Bruay Mines Co. with Carbonization at Low and Intermediate Temperatures: Chaleur et Ind., Comptes rendus du 3d Congress du Chauffage Industriel, tome I, vol. 15, March 1934, pp. 329–333. See also Berthelot, Charles, The Principle of Heating Ovens for Low-Temperature Carbonization in Accordance with the Phenomena of Fusion of Coal: Chaleur et Ind., Comptes rendus du 3d Congress du Chauffage Industrial, tome I, vol. 15, March 1934, pp. 334–340; Colliery Guardian, The French Coal Trade: Vol. 149, 1934, p. 1126; Simonovitch,—, The Belgian Semicoke: Chaleur et Ind., Comptes rendus du 3d Congress du Chauffage Industriel, tome I, vol. 15, March 1934, pp. 341–358; Berthelot, Charles, The Technique of Low-Temperature Carbonization of Coal: Génie civil, vol. 104, 1934, pp. 486–489.

43 Berthelot, Charles, The Manufacture of Artificial Anthracite: Génie civil, vol. 105, 1934, pp. 363–365.

44 Shaw, J. F., and King, J. G., Production of Smokeless Fuel in Chamber Ovens at Medium Temperatures: Gas Jour., vol. 206, 1934, pp. 603–609, 779–782; Recent Experiments at the Fuel Research Station on the Production of Solid Smokeless Fuel: Gas World, vol. 100, 1934, pp. 614–617, 670–672.

45 Same as footnote 24 on p. 693.

46 Thau, A., 70 Jahre Didier-Offenbau: Didier-Werke A. G., Berlin, Germany.

47 Georgen, O., Saar Coke: Brennstoff-Chem., vol. 15, 1934, pp. 144–145. Sainte-Claire Deville, P., The Manufacture of Special Metallurgical Coke at the Saar Mines under French Dominion: Rev. ind. min., no. 319, 1934, pp. 191–211.

48 Journal of the Fuel Society of Japan, Low-Temperature Carbonization of Coal: Vol. 14, 1935, pp. 7–8; A Large Low-Temperature Carbonization Plant: Vol. 13, 1934, p. 27; New Low-Temperature Carbonization Plant: Vol. 13, 1934, pp. 82–83.

American developments.—In 1934 approximately 27,000 tons of low-temperature coke were produced in the United States by three different plants.

Current experience in 1934 in the sale and production of Disco, the trade name under which is sold the low-volatile fuel produced by the Pittsburgh Coal Carbonization Co. under the Wisner patents, was sufficiently gratifying to warrant the action on the part of the Directors of the Company to authorize, in 1935, the construction of an additional unit. The company reports that in the household and other retail markets in which Disco has been experimentally introduced, current demand indicates a promising field for this fuel in combating the competition of oil and gas.

The first commercial unit constructed in 1933 used a 6-foot-diameter by 90-foot revolving retort to carbonize. The preliminary treatment in the first unit is done in a roaster with four superimposed rectangular hearths, over which rabbles are dragged by chains. The unit now under construction will have a carbonizer 8 feet in diameter by 90 feet, and the pretreatment will be done in a multiple hearth roaster of the wedge type. In this roaster, there will be nine circular hearths with outside diameter of 18 feet. The second unit will be in operation by the middle of 1935.[48]

The Lurgi plant of the Lehigh Briquetting Co. near Dickenson, N. Dak., operated during 6½ months of 1934 and produced 13,300 tons of briquets which were sold for household fuel and 106,000 gallons of lignite tar, part of which was sold for wood-preserving and disinfecting.

Operation of the Hayes process at Moundsville, W. Va., was limited to 5 weeks due to closing of the mine from which the slack coal was being obtained.

Research developments.—Patents have been issued for several new modifications of low-temperature retorts or ovens [49] and for the carbonization of mixtures of coal and oil which have been heated to just below the coking temperature in coils or confined passageways and then are discharged into coking chambers.[50]

HYDROGENATION AND LIQUEFACTION OF COAL

The coal-hydrogenation plant of Imperial Chemical Industries just completed at Billingham, Durham, England, has made its first shipment of gasoline—some 300,000 gallons—produced by the hydrogenation of creosote. Deliveries of gasoline from the direct hydrogenation of coal will begin about May 1. The plant is expected to produce 150,000 tons of gasoline annually at a cost of about 7d. per gallon.[51]

During the past year the German Government has brought strong pressure on the coal operators and chemical companies to increase the production of oil from brown coal and bituminous coal.[52] The output of gasoline from lignite tar and lignite at the Leuna plant of the I. G. Farbenindustrie was increased from about 100,000 metric tons in 1933 to about 180,000 tons in 1934.[53] The capacity is estimated at 350,000 tons per annum.

[48] Communication to the author.

[49] Komerek, Gustav (to Berwind Fuel Co.), Apparatus for Carbonization and Distillation of Solid Hydrocarbons: U. S. Patent 1982523, Nov. 27, 1934. Pieters, Julien, Improvements in Vertical Continuous Distillation Retorts: British Patent 410711, May 24, 1934. Kroupa, Gustav, The Adapting of a Shaft Furnace as a Retort for the Low-Temperature Carbonization of Fuels: Montan. Rundschau, vol. 26, 1934, p. 2.

[50] Bahlka, Wm. H. (to the Standard Oil Co.), Bituminous Material Carbonization: Canadian Patent 343631, July 31, 1934. Morrell, Jacque C. (to Universal Oil Products Co.), Treatment of Hydrocarbon Oils and Coal: U. S. Patent 1972944, Sept. 11, 1934.

[51] Petroleum Times, I. C. I. Output to Be Raised 50 Percent: Vol. 32, 1934, p. 525; vol. 33, 1935, p. 109. See also Gordon, K., The Hydrogenation of Bituminous Coal: Proc. World Petrol. Cong., London, 1933, vol. 2, pp. 317–322. Jones, W. Idris, Hydrogenation of Coal: Chem. and Ind., 1934, pp. 321–326.

[52] Tupholme, C. H. S., Continental Hydrogenation Plants for Coal: Ind. and Eng. Chem., news ed., vol. 13, 1935, p. 161.

[53] Institution of Mining Engineers, Utilization of Coal Committee, Summary of Progress 4, Dec. 31, 1934, p. 2. See also Bosch, C., Where There is a Will There is a Way: Ind. Chem., vol. 10, 1934, pp. 90–94, 113.

The experimental plant of the I. G. Farbenindustrie at Oppau, Germany, successfully hydrogenated gas-flame coal from the Ruhr, yielding 65 to 70 percent oil and 14 percent gaseous products, of which 30 to 40 percent were propane and butane. Compared with the product obtained from brown coal the bituminous product is poorer in lubricating oils and paraffins and richer in aromatic hydrocarbons. A full-size plant for the production of several thousand tons per year is under construction at Oppau.[54]

Hydrogenation research.—Methods, apparatus, and catalysts for the hydrogenation of coal and tar constituted the subject of considerable research,[55] and innumerable patents [56] of which a few have been taken out by American investigators.[57] Tar oils and colloidal solutions of coal appear to be more amenable to hydrogenation than undispersed coal. A tar oil requires only one-third of the hydrogen required for the hydrogenation of coal and the weight yield of gasoline is 80 percent compared to 60 percent for coal.[58] The capital cost of a tar-hydrogenation plant is considerably less than that for coal.

The Fuel Research Station of Great Britain has given tar first and coal second place on its hydrogenation-research program.[59] Experi-

[54] Iron and Coal Trades Review, vol. 129, 1934, p. 1024; Petrol. Times, German Synthetic Motor Fuel: Vol. 32, 1934, pp. 419–420; Braunkohle, Hydrogenation of Bituminous Coal: Vol. 33, 1934, p. 766. Pier, M., The Hydrogenation of Coal. German Progress: Colliery Guardian, vol. 150, 1935, pp. 433–434. Pier, M., and Gordon, K., The Hydrogenation of Bituminous Coal: Chem. and Ind., vol. 54, 1935, pp. 284–288. Pier, M., The Problem of Coal Hydrogenation: Chem. Fabr., vol. 8, 1935, pp. 45–54.

[55] Foxwell, G. E., Hydrogenation's Future and Coal Utilization: Fuel Econ., vol. 9, 1934, pp. 370–372; Petrol from Cheliabinsk Coal: Petrol. Times, vol. 31, 1934, p. 346. Rapoport, I. B., Orechkin, D. B., and Chufarovskii, V. N., Destructive Hydrogenation of Coals; Khim. Tverdogo Topliva, vol. 5, 1934, pp. 83–91; Chem. Abs., vol. 28, 1934, p. 6550. Klyukvin, N. A., Voronov, F. N., Preis, M. O., Destructive Hydrogenation of Fuels: O. N. T. I. Goskhimtekhizdat (Leningrad), vol. 1, 1934, pp. 202–203; Khim Tverdogo Topliva, vol. 3, 1932, pp. 135–146; Chem. Abs., vol. 28, 1934, p. 5645. Berthelot, Charles, The Hydrogenation of Coal and Primary Tar: Chim. et ind., vol. 31, 1934, pp. 522–536, 786–795. Rosendahl, F., Hydrogenation of Coal in Germany: Naturwissenschaft, vol. 22, 1934, pp. 554–557; Chem. Abs., vol. 29, 1935, p. 577; Fuel Econ., vol. 9, 1934, p. 370. Fenske, Merrill, R., Hydrogenation: Chem. and Met. Eng., vol. 41, 1934, pp. 272–273. Fussteig, R., Recent Progress made in the Hydrogenation of Hydrocarbons: Chim. et ind., vol. 31, 1934, pp. 1278–1290. Jones, W. Idris, Hydrogenation of Coal: Chem. and Ind., vol. 53, 1934, pp. 321–326. Cawley, C. M., and Hall, C. C., A Review of Some of the Reactions Involved in the Hydrogenation-Cracking of Tar: Chem. and Ind., vol. 53, 1934, pp. 806–811. Asbury, W. C. (to Standard I. G. Co.), Process for Treatment of Carbonaceous Materials: U. S. Patent 1934028, Nov. 7, 1933; Sinnatt, F. S., Hydrogenation of Low-Temperature Tar and Tar Products: Gas Jour., vol. 208, 1934, pp. 433–438; Gas World, vol. 101, 1934, pp. 556–559. Wright, C. A., Process for Obtaining Valuable Products from Coal and Other Carbonaceous Materials and Improved Apparatus for Such a Process: U. S. Patent 1934023, Nov. 7, 1933. Pier, Mathias, and Winkler, K., Production of Catalysts: U. S. Patent 1946108, Feb. 6, 1934. Pier, Mathias, Conversion of Carbonaceous Materials into Useful Hydrocarbon Products: U. S. Patent 1955829, Apr. 24, 1934. Pier, Mathias, and Wissel, K., Valuable Hydrocarbons by Destructive Hydrogenation: U. S. Patent 1963759, June 19, 1934. Hollings, H., Bruce, R. N. B. D., Griffith, R. H., Plant, J. H. G., and Hill, S. G., Catalysis in Hydrocarbon Chemistry. I. High-Pressure Hydrogenation of Coal Tar: Proc. Royal Soc. (London), vol. A148, 1935, pp. 186–190; II. Decomposition of Low-Boiling Hydrocarbons, pp. 191–194; III. Adsorption by Hydrogenation Catalysts, pp. 194–206.

[56] Hupe, R., and Kreisler, A. V., List of Patents on Apparatus for Coal Hydrogenation: Chem. Appl., vol. 21, 1934, pp. 33–34, 41–45, 64–66, 143–148. Hugel, C., Destructive Hydrogenation as a Tool for Studying the Constitution of Bituminous Coal Tar: 9th Internat. Cong. on Pure and App. Chem., Madrid, Spain (1934). Waterman, H. I., Results of Hydrogenation Research Work in the Past Ten Years in the Laboratory of Delft University: World Petrol. Cong., London, vol. 2, 1933, pp. 322–325.

[57] Wright, C. A. (to Standard I. G. Co.), Obtaining Valuable Products from Coal and Other Carbonaceous Materials: U. S. Patent 1934023, July 7, 1933. Harding, C. T. (to Standard I. G. Co.), Hydrogenation of Hydrocarbon Materials: U. S. Patent 1948378, Feb. 20, 1934. Russell, R. P. (to Standard I. G. Co.), Conducting High-Temperature Hydrogenation Processes: U. S. Patent 1949631, Mar. 6, 1934; Production of Low-Boiling from Higher-Boiling Hydrocarbons by the Action of Hydrogen at Elevated Temperatures: U. S. Patent 1949632, Mar. 6, 1934. Wilson, Robert E. (to Standard Oil Co. of Indiana), Hydrogenation of Pressure Tar: U. S. Patent 1960885, May 29, 1934. International Hydrogenation Patents Co., Ltd. (to I. G. Farbenindustrie Aktiengesellschaft), Improvements in or Relating to the Production of Hydrocarbons of Low Boiling Point by the Destructive Hydrogenation of Solid Carbonaceous Materials: British Patent 407227, Mar. 15, 1934. Potts, Harold Edwin (for International Hydrogenation Patents Co., Ltd.), Process for the Hydrogenation under Pressure of Distillable Carbonaceous Materials: British Patent 407992, Mar. 26, 1934; British Patent 408002, Mar. 24, 1934; British Patent 408255, Mar. 26, 1934; British Patent 408004, Mar. 24, 1934, British Patent 408003, Mar. 24, 1934. Pier, Mathias, Pross, Albert, Urban, Wilhelm, and Krönig, Walter (I. G. Farbenind. A.-G.), Destructive Hydrogenation of Solid Fuels: German Patent 597255, May 19, 1934.

[58] Hollings, H., Gas, Carbonization, Tar and Tar Products: Repts. of Progress of App. Chem., Soc. of Chem. Ind., vol. 19, 1934, pp. 75–78.

[59] Sinnat, F. S., Hydrogenation of Low-Temperature Tar and Tar Products: Gas Jour., vol. 208, 1934, pp. 433–438; Gas World, vol. 101, 1934, pp. 556–559. Hydrogenation of Coal: Fuel Econ., vol. 10, 1934, pp. 643–646. Barber, A. I., and Taylor, A. H., High-Pressure Plant for Hydrogenation Processes: Engineer, vol. 138, 1934, pp. 576–578, 635–636. King, J. G., The Conversion of Creosote into Motor Spirit. Details of Experimental Work at Fuel Research Station: Gas Eng., vol. 52, 1935, pp. 15–17; Report of the Fuel Research Board, 1934, pp. 73–106.

ments are conducted with batch and continuous converters, the latter being heated either externally or internally. The best catalysts are the halides and sulphides of molybdenum and tungsten deposited on alumina gel operating at 450° C. and 200 atmospheres pressure.[60]

Other laboratories also have published data on yields obtained from low-[61] and high-temperature tar, phenolic oil,[62] benzene,[63] pitch,[64] etc.,[65] under different conditions of hydrogenation.

Several workers have investigated the dispersion of coals with pyridine, tetralin, aniline, quinoline, phenols, diphenyl,[66] and anthracene oil at various temperatures and pressures. The extractions are hydrogenated easily and yield a large percentage of oils.[67] Pott and Broche [68] obtained as high as 80-percent yields from bituminous coals by stage extraction with mixed solvents, such as tetralin and low-temperature tar phenols, keeping the temperature just under the decomposition temperature of the material. The extracts hydrogenated readily.

SYNTHETIC PRODUCTS FROM GASES

A commercial-scale pilot plant, using the Fischer process [69] for the production of motor fuel and lubricating oil [70] from water gas, is being built by the Ruhrchemie A. G. in Oberhausen-Holten, Ruhr, Germany. The gas (1 part CO to 2 parts H_2 by volume), completely

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60 Cawley, C. M., and Hall, C. C., A Review of Some of the Reactions Involved in the Hydrogenation Cracking of Tar: Chem. and Ind., vol. 53, 1934, pp. 806–811. Cawley, C. M., Hall, C. C., and King, J. G., Hydrogenation Cracking of Creosote: Jour. Soc. Chem. Ind., vol. 54, 1935, pp. 58–62 T.

61 Hollings, H., Bruce, R. N. B. D., and Griffith, R. H., Catalysis in Hydrocarbon Chemistry, I. High-Pressure Hydrogenation of Tar and Creosote: Proc. Royal Soc., London, 1935, A863; High-Pressure Hydrogenation of Tar and Creosote: Gas. Jour., vol. 209, 1935, pp. 438–439. Ando, S., High-Pressure Hydrogenation of Low-Temperature Tar, I. Effects of Hydrogenating Conditions: Petrol. Times, vol. 32, 1934, pp. 176–177; Jour. Soc. Chem. Ind. Japan, vol. 37, 1934, pp. 357B–361B. Klimov, B. K., Lanin, V. A., and Alek Sandrov, A., Destructive Hydrogenation of Tars and Oils: O. N. T. I. Goskhimtekhizdat (Leningrad), vol. 1, 1934, pp. 241–255. Naplitale, M., Low-Temperature Tar from Bituminous Coal: Brennstoff Chem., vol. 16, 1935, pp. 67–72. Ivanov, K. I., Falin, V. F., and Morozova, N. V., Experimental Hydrogenation of the Residue from the Primary Tar from Barzass Coals for the Special Purpose of Obtaining Lubricating Oils: O. N. T. I. Goskhimtekhizdat (Leningrad), vol. 1, 1934, pp. 265–274. Nemtzov, M. S., Destructive Hydrogenation in the Presence of Catalysts: O. N. T. I. Goskhimtekhizdat (Leningrad), vol. 1, 1934, pp. 119–141. Tarasov, B. K., and Soledzhiev, G. N., Hydrogenation of Kashpira Tar: O. N. T. I. Goskhimtekhizdat (Leningrad), vol. 1, 1934, pp. 223–228. Rapopart, I. B., Polozov, V. F., and Konov, V., Destructive Hydrogenation of Tars: O. N. T. I. Goskhimtekhizdat (Leningrad), vol. 1, 1934, pp. 35–47. Petrov, A. D., Hydrogenation of Topped Crude and of Petroleum Cracked Residues, Primary Shale, and Coal Tars, Asphalts, and Phenols: O. N. T. I. Goskhimtekhizdat (Leningrad), vol. 1, 1934, pp. 228–240.

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purified from sulphur, is passed over a catalyst of nickel-aluminum-manganese on kieselguhr at 190° to 210° C. and atmospheric pressure. Motor-fuel yields are estimated at 100 to 120 grams per cubic meter of gas used and the cost of 22 pf. per kilogram.[71]

The Fischer process has interested Japanese chemists, who have checked many of Fischer's findings and have published considerable additional data on catalysts and the influence of various factors on the reactions.[72] Secondary reactions were investigated by Simek and Kasster.[73]

Pyrolysis of hydrocarbons.—The obvious importance of better knowledge of the mechanism of thermal decomposition of hydrocarbons in connection with the production of synthetic fuels and useful chemical compounds has enlisted an increasing number of workers in this field, who have made important progress in the last few years. Travers and Pearce [74] investigated the system ethane-ethylene-hydrogen and determined its equilibrium constant. Bunte and Lang [75] reviewed pyrolysis of paraffins in general and determined the most favorable catalysts and conditions for production of methane rich gas from oil. Dunstan, Hague, and Wheeler [76] present experimental data and theoretical deductions on the mechanism of thermal conversion of paraffins and olefines into aromatic hydrocarbons.

The results of research on the pyrolysis and conversion of hydrocarbons to motor fuels, lubricants, and other products, especially through the polymerization of acetylene and ethylene, have been published by the United States Bureau of Mines,[77] the National Research Council of Canada,[78] and others.[79] A number of patents [80] also have been granted for the conversion into liquid products of the unsaturates in still gases of petroleum refineries.

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FUEL BRIQUETS

By W. H. Young and J. B. Clark

SUMMARY OUTLINE

Production of fuel briquets in 1934 amounted to 704,856 net tons valued at $4,276,466, according to reports furnished to the Bureau of Mines by operators of briquetting plants. Compared with 1933, production increased 32.9 percent and value 22.2 percent.

The progress of the industry since 1907, the date of the first statistical survey covering fuel briquets, is recorded in the following table:

Salient statistical trends in the fuel-briquet industry in the United States, 1907–34

Year or yearly average	Production of briquets: Eastern States (thousands of net tons)	Production of briquets: Central States (thousands of net tons)	Production of briquets: Pacific Coast States (thousands of net tons)	Production of briquets: Total (thousands of net tons)	Imports (thousands of net tons)	Consumption [1] (thousands of net tons)	Value of product, thousands of dollars	Number of plants in operation	Average output per plant, tons	Average value per ton f.o.b. plant: Pennsylvania	Average value per ton f.o.b. plant: Central States
YEARLY AVERAGE											
1907–9	(2)	(2)	(2)	99	(3)	99	345	12	8,691	(2)	(2)
1912–15	76	90	53	219	(3)	219	1,037	17	13,179	$2.68	$4.62
1916–20	129	172	107	408	(3)	408	2,763	13	30,640	4.17	7.48
1921–25	188	299	140	627	12	639	5,418	14	43,672	6.04	9.07
1926–30	268	648	115	1,031	84	1,115	8,354	22	47,646	6.42	8.36
YEAR											
1929	325	788	99	1,212	89	1,301	9,515	25	48,497	6.22	8.13
1930	301	641	87	1,029	73	1,102	8,029	25	41,155	6.22	8.13
1931	243	382	73	698	61	759	5,261	27	25,864	5.90	8.11
1932	128	296	47	471	80	551	3,459	26	18,100	5.21	7.60
1933	155	318	57	530	42	572	3,498	27	19,646	4.89	6.71
1934	264	388	53	705	-------	705	4,276	27	26,106	4.69	6.54

[1] Production plus imports; the quantity exported has been negligible.
[2] Not available before 1912.
[3] No record of imports is available before 1919, but the quantity imported prior to that time was negligible.

The outstanding feature in production for 1934 was the extremely large increase in the Eastern States—69.6 percent over 1933. Output in the Central States also increased substantially whereas that in the Pacific Coast States declined slightly.

In 1934, as in other recent years, Wisconsin ranked first as a producer of briquets; its 5 plants made 46.8 percent of the entire production. The combined output of Wisconsin and Pennsylvania constituted 63.7 percent of the total tonnage for the country.

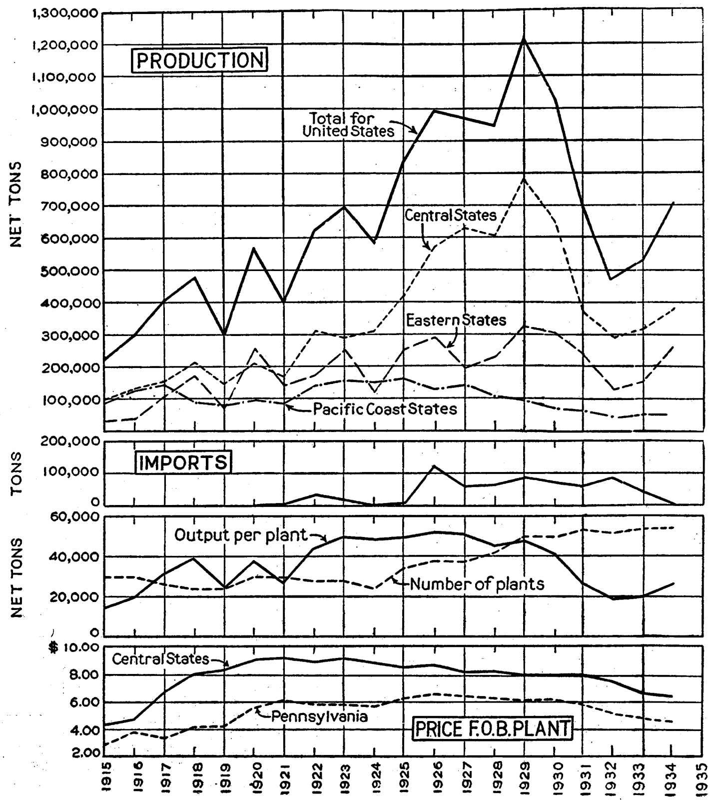

FIGURE 58.—Production and imports of fuel briquets, number of plants in operation, and average prices received, f. o. b. plants, 1915–34.

Fuel briquets produced in the United States, 1933–34

	Production			Value		
	1933	1934	Increase or decrease	1933	1934	Increase or decrease
	Net tons	*Net tons*	*Percent*			*Percent*
Eastern States	155,469	263,734	+69.6	$740,672	$1,245,973	+68.2
Central States	318,163	388,557	+22.1	2,136,054	2,540,221	+18.9
Pacific Coast States	56,798	52,565	−7.5	621,554	490,272	−21.1
	530,430	704,856	+32.9	3,498,280	4,276,466	+22.2

Monthly production of fuel briquets in the United States, 1932–34, in net tons

Month	1932	1933	1934	Month	1932	1933	1934
January	58,380	42,548	83,607	August	36,287	52,008	38,265
February	45,649	42,682	71,757	September	44,332	49,844	64,420
March	29,848	20,381	55,550	October	65,695	76,061	77,896
April	14,223	26,252	29,104	November	55,157	64,421	83,467
May	25,433	37,214	39,692	December	60,341	74,797	111,836
June	16,845	24,079	22,581				
July	18,414	20,143	26,681		470,604	530,430	704,856

Value.—The total value of the briquets manufactured in 1934 was $4,276,466, a gain of $778,186 over 1933. However, the average value per net ton, f. o. b. plant, for the country as a whole—$6.07 in 1934 compared with $6.60 in 1933 and $7.53 in 1931—has a doubtful significance because of different conditions governing the cost of raw materials and the cost of manufacturing in different sections of the country. The average values, 1932–34, for the three major sections are given in the following table:

Average value per net ton of fuel briquets produced in the United States, 1932–34

	1932	1933	1934
Eastern States	$5.21	$4.76	$4.72
Central States	7.60	6.71	6.54
Pacific Coast States	11.57	10.94	9.33
	7.35	6.60	6.07

Number and capacity of plants in operation.—Twenty-seven plants, the same number as in 1933, reported production of briquets on a commercial scale in 1934. The number of plants in operation has increased steadily from 11 in 1907 to 27 in 1934. The average production per plant in 1934 was 26,106 tons, an increase of 6,460 tons over 1933.

The number of briquetting operations and the average output per plant over an extended period are indicated in the table on page 711.

The total annual capacity of the 27 plants operating in 1934 was 3,194,730 net tons and the production only 704,856 net tons. The following instructions were given to the manufacturers in preparing data on capacity: "In stating capacity, please give total quantity of briquets that could actually be produced in an entire year, operating your customary number of shifts per day and allowing for unavoidable shut-downs for cleaning and repairs." Each operator's reply to this question was checked against the monthly production record of the plant in order to find out how the reported annual capacity compared with the peak monthly output multiplied by 12. In 4 cases it was found that the plant had produced for 1 month or more at a rate substantially greater than the capacity originally reported, and the capacity was adjusted accordingly. The net adjustment in 1934 resulting from this and certain other small changes amounted to an increase of 280,000 tons.

Classification of briquet plants, by yearly capacity in 1934

Capacity per year, net tons:	Number of plants
Less than 5,000	2
5,000 and less than 10,000	4
10,000 and less than 25,000	6
25,000 and less than 100,000	8
100,000 and less than 200,000	1
200,000 and less than 400,000	4
400,000 and over	2
	27

Two plants active in 1933 produced no briquets in 1934, but two additional plants—the Calkins Pressed Fuel Co. of Renton, Renton, Wash., and the Covington Coal Co., Tahona, Okla.—reported production during the year. One plant, the Winding Gulf Collieries, operated in 1934 but was dismantled in December.

Briquetting plants operated in the United States in 1934

State	Name and address of operator	Location of plant	Date put in operation	Raw fuel used, as reported by producer
Eastern States:				
Massachusetts	American Briquet Co., 1505 Philadelphia Bank Building, Philadelphia, Pa.	Charlestown	1929	Anthracite.
Do	Staples Coal Co., 80 Federal Street, Boston, Mass.	Fall River	1932	Anthracite and bituminous slack.
New Jersey	Navicoal Corporation, 1421 Chestnut Street, Philadelphia, Pa.	Keasbey	1925	Do.
Ohio	Trustees of The Consolidation Coal Co., Debtor, 811 Race Street, Cincinnati, Ohio.	Cincinnati	1932	Semibituminous slack.
Pennsylvania	American Briquet Co., 1505 Philadelphia Bank Building, Philadelphia, Pa.	Lykens	1920	Anthracite.
Do	Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa.	Philadelphia	1933	Petroleum coke.
Do	Henriette Coal Mining Co., 15 Moore Street, New York, N. Y.	Dunlo	1929	Semibituminous slack.
West Virginia	Berwind Fuel Co., of West Virginia, 122 South Michigan Avenue, Chicago, Ill.	Berwind	1929	Bituminous slack.
Do	Raleigh-Wyoming Mining Co., 230 South Clark Street, Chicago, Ill.	Glen Rogers	1932	Do.
Do	Winding Gulf Collieries, P. O. Box 30, Bluefield, W. Va.	Davy	1930	Do.
Central States:				
Colorado	Acme Smokeless Fuel Co., 212 Davidson Building, Bay City, Mich.	Salida	1931	Anthracite and bituminous slack.
Missouri	Standard Briquet Fuel Co., 6700 Manchester Avenue, St. Louis, Mo.	Kansas City	1909	Semianthracite.
Nebraska	Christopherson-Renstrom Co., Thirty-first Avenue and Sahler Street, Omaha, Nebr.	Omaha	1932	Petroleum coke.
North Dakota	Lehigh Briquetting Co., Union Building, Fargo, N. Dak.	Lehigh	1929	Lignite char.
Oklahoma	Covington Coal Co., 411 First National Bank Building, Fort Smith, Ark.	Tahona	1934	Semibituminous slack.
Do	Superior Smokeless Coal & Mining Co., 20 North Wacker Drive, Chicago, Ill.	do	1933	Semianthracite.
Texas	Magnolia Petroleum Co., P. O. Box 3311, Beaumont, Tex.	Chaison	1930	Petroleum coke.

Briquetting plants operated in the United States in 1934—Continued

State	Name and address of operator	Location of plant	Date put in operation	Raw fuel used, as reported by producer
Central States—Con.				
Wisconsin	Berwind Fuel Co., 122 South Michigan Avenue, Chicago, Ill.	Superior	1912	Semibituminous slack.
Do	Panda Briquet Co., 1011 Foshay Tower, Minneapolis, Minn.	Ashland	1931	Do.
Do	C. Reiss Coal Co., Reiss Building, Sheboygan, Wis.	Sheboygan	1933	Do.
Do	Stott Briquet Co., Inc., 1204 East First National Bank Building, St. Paul, Minn.	Superior	1909	Anthracite and bituminous slack.
Do	United Coal & Dock Co., 102 West Wells Street, Milwaukee, Wis.	Milwaukee	1928	Semibituminous slack and high-temperature coke.
Pacific Coast States:				
California	California Fuel & Utilities, Inc., P. O. Box 735, Compton, Calif.	Dominguez	1931	Petroleum coke.
Do	Los Angeles Briquet & By-Product Co., 6623 McKinley Avenue, Los Angeles, Calif.	Los Angeles	1933	Do.
Oregon	Portland Gas & Coke Co., Public Service Building, Portland, Oreg.	Portland	1913	Carbon residue from oil gas.
Washington	Calkins Pressed Fuel Co. of Renton, Renton, Wash.	Renton	1934	Bituminous slack and black lignite.
Do	Pacific Coast Coal Co., Smith Tower, Seattle, Wash.	do	1914	Bituminous slack.

Classification of briquet plants, by size of output, 1932–34

Output, net tons	Number of plants			Output, net tons	Number of plants		
	1932	1933	1934		1932	1933	1934
Less than 2,000	9	6	8	25,000 and less than 100,000	7	8	8
2,000 and less than 5,000	2	4	3	100,000 and over			1
5,000 and less than 10,000	5	6	3				
10,000 and less than 25,000	3	3	4		26	27	27

Classification of briquet plants, by number of hours operated per day during busy season, 1933–34

Hours per day	Number of plants		Production, net tons	
	1933	1934	1933	1934
14 to 24 hours	14	15	402,905	568,782
8 to 12 hours	12	9	127,525	129,168
Less than 8 hours	1	3		6,906
	27	27	530,430	704,856

Raw fuels.—The raw fuel used for the manufacture of briquets in the United States is some form of slack, fine coal, or other finely divided carbon usually unsuited to household use. A total of 672,225 net tons was briquetted in 1934; 36 percent of this amount was anthracite and semianthracite, 52 percent semibituminous and bituminous coal, and 12 percent semicoke, oil-gas residue, and petroleum coke.

Seven plants reported that from a small part to all of the raw coal used was washed either by the colliery operator or by the briquet manufacturer.

Raw fuels used in making briquets in the United States, 1929–34, in net tons

Fuel	1929	1930	1931	1932	1933	1934
Anthracite culm and fine sizes and semianthracite	408,967	368,294	243,888	151,400	157,972	240,273
Semibituminous and bituminous slack	711,459	569,057	360,226	260,050	282,400	347,446
Semicoke, oil-gas residue, and petroleum coke	67,513	67,014	67,064	50,989	71,070	84,506
	1,187,939	1,004,365	671,178	462,439	511,442	672,225

Classification of briquet plants, by kinds of raw fuel used in 1934

Kind of raw fuel used:	Number of plants
Anthracite or semianthracite fines	4
Mixture of anthracite or semianthracite fines and bituminous or semibituminous slack	4
Bituminous slack	5
Semibituminous fines	7
Semicoke (low-temperature coke or char)	1
Carbon residue from the manufacture of oil gas	1
Petroleum coke	5
	27

Weight and shape.—The smaller sizes of briquets (those weighing less than 3 ounces) continued to predominate in the American industry, 75.9 percent of the total manufactured in 1934 being of this type compared with 71.8 percent in 1933; 22.5 percent weighed 3 to 5 ounces compared with 27.4 percent in 1933. Thus, 98.4 percent of the briquets manufactured in 1934 weighed less than 5 ounces, and only 1.6 percent weighed 5 ounces or more.

Of the 27 producing plants, 17 manufactured pillow-shaped briquets. Of the others, 3 made cylindrical briquets, 1 ovoid, 1 both cylindrical and ovoid, 1 both cylindrical and pillow, 1 both rectangular and ovoid, and 3 made large cubes.

Classification of briquet plants, by prevailing weight of briquets manufactured, 1933–34

Weight of briquet, ounces	Number of plants		Percent of production		Weight of briquet, ounces	Number of plants		Percent of production	
	1933	1934	1933	1934		1933	1934	1933	1934
Less than 2	7	7	71.8	75.9	5 and under 6		[2] 1	0.8	1.6
2 and under 3	11	10			6 and under 10	1	1		
3 and under 4	3	2	27.4	22.5	10 and under 16	1	(3)		
4 and under 5	2	[1] 3			42 and over	2	[4] 3		
						27	27	100.0	100.0

[1] Includes one plant making 10-ounce briquets; tonnage unknown.
[2] This plant also produced some briquets weighing 5 pounds; tonnage unknown.
[3] Included under classification "4 and under 5", as stated in footnote 1.
[4] One plant producing briquets weighing 5 pounds included under classification "5 and under 6", as stated in footnote 2.

Binders and recarbonization.—Asphaltic pitch is the binder preferred in the manufacture of fuel briquets, 16 of the 27 plants active in 1934 using asphaltic pitch exclusively. Of the other plants using binders, 1 used asphaltic pitch and corn flour; 2, petroleum asphalt; 2, starch, asphalt, and water; 1 mixed pitches; 1, cement; 1, aspholeum; and 2, briquetting asphalt. One plant briquetting the carbon residue from the manufacture of oil gas required no binder.

The percentage of binder to raw fuel, by weight, ranged from less than 5 to more than 9. The proportion used most was 5 to 8 percent.

Classification of briquet plants, by percentage of binder used in 1934

Binder used:	Number of plants
Using no binder (carbon residue)	1
Using—	
Less than 5 percent binder	3
5 and less than 7 percent	14
7 and less than 9 percent	6
9 percent and over	3
	27

One producer using a binder reported recarbonizing the briquets coming from the presses to drive off smoke from the binder. Two other producers reported partly recarbonizing the briquets.

DISTRIBUTION

The tonnage produced in 1934 was distributed widely, briquets being shipped into 41 States, the District of Columbia, and Alaska, as well as being exported to Canada. A close study of the accompanying table will reveal the extent to which the industry is expanding. Compared with 1933 exports increased 612 percent, shipments into New York 649 percent, and shipments into Michigan 153 percent.

It should be noted that commercial sales were slightly less than output; changes in producers' stocks account for the difference.

Fuel briquets of domestic manufacture consumed in the United States and exported to Canada, 1933–34, in net tons

Shipped into—	1933	1934	Shipped into—	1933	1934
Alaska	344	218	New Hampshire	2,204	3,046
Arizona	48	18	New Jersey	3,917	4,369
California	7,733	4,398	New Mexico	91	88
Colorado	765	908	New York	5,724	42,897
Connecticut	455	1,545	North Carolina	2,208	3,618
Delaware	378	377	North Dakota	46,746	50,525
District of Columbia	569	312	Ohio	6,166	10,074
Florida	122	302	Oklahoma	88	241
Idaho	81	285	Oregon	36,061	33,974
Illinois	6,218	12,606	Pennsylvania	10,703	13,427
Indiana	3,916	5,794	Rhode Island	5,202	6,861
Iowa	19,269	22,713	South Carolina	143	415
Kansas	4,243	5,278	South Dakota	28,704	34,401
Kentucky	--------	264	Texas	3,178	3,657
Louisiana	839	799	Vermont	41	295
Maine	1,240	1,578	Virginia	6,286	13,646
Maryland	3,378	3,799	Washington	11,444	12,658
Massachusetts	61,831	76,875	West Virginia	119	1,144
Michigan	8,777	22,185	Wisconsin	89,131	104,885
Minnesota	133,102	168,067	Wyoming	145	--------
Missouri	4,360	5,904	Miscellaneous	2,261	--------
Montana	99	22	Canada	1,810	12,889
Nebraska	8,992	16,171			
Nevada	31	64		529,162	703,592

FOREIGN TRADE [1]

The importation of fuel briquets began to slacken early in 1933, and no tonnage was reported for 1934 by the Bureau of Foreign and Domestic Commerce.

Briquets and other composition coals [1] for fuels imported for consumption in the United States, 1929–34

Year	Net tons	Value	Year	Net tons	Value
1929	89,458	$458,517	1932 [1]	80,288	$335,358
1930	73,418	399,146	1933 [1]	42,395	126,157
1931	60,950	325,189	1934	(2)	(2)

[1] Beginning July 1, 1932—coal and coke briquets only.
[2] None reported for 1934.

Fuel briquets imported into the United States, 1932–33, by months, in net tons [1]

Month	1932	1933	Month	1932	1933
January	6,409	14,783	August		
February	15,176	11,293	September	6,873	
March	7,996	10,797	October	5,687	
April	5,715		November	6,162	
May	11,078		December	10,488	
June	4,704	5,522			
July				80,288	42,395

[1] None reported for 1934.

World production of fuel briquets, 1930–34, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
Algeria	96,812	73,828	71,000	19,689	(2)
Australia: Victoria	184,000	296,000	325,000	315,754	(2)
Belgium	1,875,210	1,850,360	1,316,990	1,384,000	1,350,800
Czechoslovakia:					
Coal	239,080	285,782	406,574	396,840	386,463
Lignite	180,718	209,435	202,003	199,653	197,434
France	6,810,000	7,185,830	7,537,000	7,530,000	7,635,000
Germany: [3]					
Coal	5,176,628	5,186,566	4,375,512	4,863,940	4,819,171
Lignite	33,988,162	32,422,214	29,752,172	30,064,899	31,418,809
Saar		1,178	6,939	(2)	(2)
Great Britain	1,149,114	883,498	923,048	940,723	(2)
Hungary:					
Coal } Lignite }	101,009	184,544	414,421	371,550	(2)
Indo-China	144,000	134,000	97,406	73,219	(2)
Italy	2,002	2,450	2,414	4,926	(2)
Netherlands:					
Coal	945,939	1,212,621	1,170,930	1,102,551	(2)
Lignite	48,868	40,892	44,025	35,641	(2)
Netherland East Indies	52,292	17,418	6,967	32,948	(2)
Poland	234,123	300,999	222,246	221,911	(2)
Rumania	(2)	30,400	43,019	127,274	(2)
Spain	929,736	914,117	785,703	801,953	(2)
United States	933,366	633,498	426,923	481,195	639,431
Venezuela	524	(2)	555	(2)	(2)
Yugoslavia	32,413	41,083	29,851	24,015	(2)
	53,123,996	51,906,713	48,160,698	48,992,681	(2)

[1] In addition to the countries listed briquets are produced in Canada and New Caledonia, but data of output are not available.
[2] Data not available.
[3] Exclusive of the Saar.

[1] Figures on imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

PEAT

By F. M. Shore

SUMMARY OUTLINE

The production of peat in the United States in 1934, as reported to the Bureau of Mines, was 40,544 short tons, valued at $214,185. Compared with 1926, the latest previous year for which figures are available, the 1934 output represents a material decrease in quantity and an even greater decline in value. Imports of peat moss increased about 7 percent in quantity and 24 percent in value over 1933, and the quantity was about 165 percent greater than in 1926.

The principal use of peat in this country at this time is for soil improvement. Under present conditions peat is unable apparently to compete in the domestic fuel markets, and no commercial production for use as fuel was reported for 1934.

The vast proportions and wide distribution of the peat deposits of the United States afford a substantial basis for any expansion of use that technical and economic developments of the future may justify. The present position of the domestic peat industry is outlined by the data herein, which were obtained chiefly from reports supplied by producers covering their operations for 1934.

The annual canvass of the peat-producing industry, inaugurated by the United States Geological Survey in 1908, was continued without interruption to include 1926, and the results were published in the annual volumes of Mineral Resources of the United States. Until the present time no canvass of the industry had been undertaken by the Federal Government since 1926. The Bureau of Mines undertook the task of gathering data covering the fundamental economic factors of peat production in 1934, believing that developments affecting the utilization of a natural resource of such vast potential value as is represented by the peat deposits of the Nation should have a place in the annual balance sheet of the productivity of the country. Since the output of the majority of the peat-producing plants is small and operations are scattered widely, efforts to locate the plants now in existence have entailed considerable difficulty and delay. Although the completeness of the returns from the producing industry cannot be assured it is believed that the results obtained represent a substantial coverage of the field.

Reserves.—The total quantity of known peat in the United States, exclusive of Alaska, calculated as air-dried peat, has been estimated to be 13,827,000,000 tons.[1] Minnesota has the largest reserves of peat—

[1] Soper, E. K., and Osbon, C. C., The Occurrence and Uses of Peat in the United States: U.S. Geol. Survey Bull. 728, 1922, p. 92.

6,835,000,000 tons—Wisconsin, Florida, and Michigan following in order of quantity. The northern region, embracing the New England States, those bordering on the Great Lakes, and Iowa, contain 11,050,000,000 tons—80 percent of the total deposits of the country. Three States in this region—Minnesota, Wisconsin, and Michigan—together account for about 75 percent of the estimated peat deposits of the country. The Atlantic coastal region holds about 19 percent of the total peat reserves, and the Pacific and Gulf Coast States (exclusive of Florida) have less than 1 percent of the total reserves. Although little use is now being made of this vast and wide-spread natural resource its immediate availability for soil improvement and other purposes is recognized in many regions, and its ultimate value as a source of power and heat when the present supply of high-grade fuels has become depleted makes it an important national asset.

Production.—Returns covering 1934 were received from 36 operators. The total production of peat of all kinds and grades reported by these operators was 40,544 short tons having a total value of $214,185 at producing plants. Fifteen States shared in the peat production in 1934, representing the deposits of New England and New Jersey, the States adjoining the Great Lakes, Iowa, the Pacific coast, and Florida. New Jersey was the largest producer, but its tonnage cannot be shown separately. Other States producing peat were Iowa, Michigan, California, Colorado, Florida, Illinois, Indiana, Massachusetts, Maine, Minnesota, New Hampshire, New York, Ohio, and Pennsylvania. Except for one government agency, the Iowa State Highway Commission, the production reported came from privately owned plants. In a few instances the quantity sold has been used in lieu of production figures that were not available.

An effort was made in 1935 to obtain data showing the quantity and value of peat production from 1927 and 1933, inclusive, but the results obtained were too meager to be of practical value.

Quantity and value of peat produced in the United States, 1917–26 and 1934 [1]

Year	Short tons	Value	Year	Short tons	Value
1917	97,363	$709,900	1923	61,355	$376,834
1918	107,261	1,047,243	1924	55,469	395,470
1919	69,197	705,532	1925	72,436	452,898
1920	73,204	921,732	1926	61,936	364,413
1921	30,406	260,119	1934 [1]	40,544	214,185
1922	60,680	397,729			

[1] Data not available for 1927–33. No canvass for those years.

The wide distribution of producing operations is more significant of the scope and potential value of peat resources than of their present utilization. Remoteness of deposits from markets, cost of transportation, more readily accessible and cheaper products suitable for the uses for which peat is available, and, to some extent, inadequate knowledge of the several kinds of peat, the differences between peat deposits, and the possible uses of peat products are some of the factors that have contributed to limitation in the use of the country's peat resources.

The total production of peat in 1934 was lower than in the latest previous year of record—1926—by about 34 percent in tonnage and 41 percent in value. The average value per ton at producing plants in 1934 was $5.28 compared with $5.88 in 1926.

Operators of peat-producing plants were asked to state the kinds of peat produced, according to general classes of plant material from which the peat was formed. Sedge peat was reported by 20 operators, and moss and reed peat each were reported produced at 15 plants. A number of plants reported production of more than one kind of peat.

Reports as to the form in which the peat was produced for market indicate that 24 operators produced shredded peat, 20 raw peat, 8 cultivated peat, and 2 kiln-dried peat. As the figures indicate many of the plants produced peat in more than one form.

Uses.—Peat is used for soil improvement on lawns and golf courses, and in gardens, nurseries, and greenhouses; fuel; litter for barns and poultry yards; packing material for plants, shrubs, eggs, fruits, vegetables, and fragile articles; and insulation. Of the quantity of peat produced in 1934 none was reported as sold for use as fuel. With ample supplies of more efficient fuels available at reasonable cost it is not surprising that peat cannot share in the fuel market of the country.

The largest market for peat in this country at present appears to be in agriculture, as an ingredient of fertilizer and a soil conditioner. The quantity of peat sold for soil improvement in 1934 is not known accurately. Of the 36 producers reporting, 32 reported soil improvement as a use for the product sold, 24 reporting sales for soil improvement only. Although other uses were specified less often by the companies reporting the available information indicates that peat was sold in 1934 for use as a litter for livestock and poultry, for use by florists for packing plants, for insulation, and as a fertilizer filler and mulch.

For a more comprehensive account of the uses for which the various grades of peat are adapted, the following Government publications and works cited therein will be found of particular interest and value:

Dachnowski-Stokes, A. P. Grades of Peat and Muck for Soil Improvement. U. S. Department of Agriculture Circ. 290, 1933, 31 pp.

Soper, E. K., and Osbon, C. C. The Occurrence and Uses of Peat in the United States: U. S. Geol. Survey Bull. 728, 1922, 207 pp.

Odell, W. W., and Hood, O. P. Possibilities for the Commercial Utilization of Peat. Bulletin 253, Bureau of Mines, 1926, 160 pp.

Marketing.—No attempt was made to gather comprehensive data on marketing methods, but information was requested as to the means of transportation employed for the shipment of peat and as to the customary shipping units used in the trade. Operators of 20 plants reported shipments by rail, and 33 made shipments by truck; some utilized both means for getting their product to market.

In addition to bulk shipments sold by the ton or cubic yard, peat also is shipped in smaller lots in bags, bales, and crates. The weight of these units depends, of course, upon the kind and condition of the peat and the size of the container. The weight of the bags of peat, as reported by the operators in 1934, varied widely, the most common figure being 100 pounds. The price per bag varied, of course, with the volume and weight of its contents and the quality of the product.

In the shipments reported the price ranged from $0.30 to $3.00, averaging $1.07. The weight of the baled unit ranged from 50 to 200 pounds and averaged 142 pounds. The cubic yard of peat shipped in crates ranged in weight from 350 to 1,500 pounds and averaged 978 pounds.

Peat deposits may vary materially in character and in their value for specific uses, due to differences in the plant materials of which they are composed, the conditions under which they were formed, and their stage of development. Standard specifications for the various grades of peat suitable for different purposes have not yet been adopted for general use. However, some municipal and other Government agencies do specify with considerable exactness their requirements for peat and peat products, and it seems probable that the needs of the situation eventually will lead to wider use and greater uniformity of technical standards of quality in the marketing of peat. The following descriptive features of the specifications used by the Federal Government in purchasing its peat requirements will be found of interest to producers and potential users of this product: [2]

Peat:

Moss (sphagnum or moss peat); brown; acid reaction approximately 4 to 5 *pH*; free of woody material, and mineral matter such as sulphur and iron; in air dry condition; water-absorbing capacity varying from 1,100 to 2,000 percent; shall contain approximately 30 percent moisture by weight when oven dried; if satisfactory in other respects, moisture content in excess of 30 percent may be accepted, but settlement will be made on weights corrected to 30 percent moisture basis; . . .

Horticultural grade; granulated or shredded:

Poultry litter grade:

Stable bedding:

Reed muck or sedge muck (peat humus); dark brown to black; granulated; slightly acid to slightly alkaline in reaction (*pH* 5.0 to 7.5); free of lumps; low in ash content (8 to 15 percent); low in content of woody material and mineral matter such as sulphur and iron; water-absorbing capacity ranging from 100 to 350 percent; water content not to exceed 60 percent by weight when oven dried; moisture content in excess of 60 percent may be accepted, but settlement will be made on basis of weights corrected to 60 percent moisture content; . . .

Reed peat or sedge peat; brown; raw, shredded or granulated; low ash content (5 to 10 percent); low in mineral material such as iron and sulphur; low in content of woody material; water-absorbing capacity ranging from 350 to 800 percent; water content not to exceed 50 percent by weight when oven dried; if satisfactory in other respects, moisture content in excess of 50 percent may be accepted, but settlement will be made on basis of weights corrected to 50 percent moisture content:

Acid grade; reaction may vary from 4.5 to 5.5 *pH:*

Slightly acid to slightly alkaline grade, reaction may vary from *pH* 5.5 to 7.5.

Employment.—Data on employment at peat-producing operations are not complete. The working time is governed in small plants by a market that is largely local. Weather conditions limit the operating time in the northern regions. In an industry distributed so widely and sparsely there is such variety of conditions that comparisons are difficult to make. It is clear that the industry is of relatively small consequence as an employer of labor.

Information on the total man-days or man-hours worked in the peat industry is not available. However, available data indicate that the average number of men employed in 1934 at 31 plants was 138. Twenty-four plants employing an average of 114 men

[2] Treasury Department, Procurement Division, Branch of Supply, Specifications and Proposals for Supplies: Washington, D. C., 1935.

worked an average of 139 days each in 1934. Twenty-seven plants operated a total of 3,298 days, an average of 122 days per plant. The working time of all plants reporting ranged from 12 days to 300 days for the year. The length of the working day was 6 to 10 hours and averaged 8.2 hours.

Imports.—Figures on quantity and value of imports of peat moss are published each year by the Bureau of Foreign and Domestic Commerce. In 1934 the imports of peat moss were 44,132 short tons valued at $547,353. These figures represent increases over 1933 of 7.1 percent in tonnage and 23.6 percent in value. The average value per ton for the imports was $12.40 compared with $10.74 in 1933. Germany was the chief source of imported peat moss in 1934, supplying 59.3 percent of the total. Sweden was next with 30.2 percent of the total imports, while Norway, Denmark, and Canada also supplied substantial amounts.

Imports of peat moss, by countries, 1933–34, in short tons [1]

[Compiled from records of the Bureau of Foreign and Domestic Commerce]

Country	1933	1934	Country	1933	1934
Belgium	7	14	Netherlands	2,075	76
Canada	1,297	1,121	Norway	998	1,716
Czechoslovakia		24	U. S. S. R. (Russia in Europe)	1,431	444
Denmark	1,503	1,167	Sweden	6,963	13,328
Estonia		49	United Kingdom	46	29
Finland		2			
Germany	26,897	26,149		41,217	44,132
Japan		13			

[1] Data on imports, by countries, during 1934 may not be strictly comparable with figures for previous years due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in the system of reporting imports. For 1933 and earlier years the figures represent "general imports", whereas totals for 1934 represent "imports for consumption."

Peat moss imported for consumption, 1917–34

Year	Short tons	Value	Year	Short tons	Value	Year	Short tons	Value
1917	506	$4,966	1923	5,973	$43,184	1929	57,531	$657,145
1918			1924	5,541	47,208	1930	70,466	869,381
1919	464	16,345	1925	10,233	121,719	1931	63,928	682,553
1920	2,762	36,201	1926	16,669	174,241	1932	64,701	601,372
1921	3,450	22,754	1927	31,595	326,549	1933	41,217	442,766
1922	4,805	33,034	1928	40,087	422,275	1934	44,132	547,353

CRUDE PETROLEUM AND PETROLEUM PRODUCTS[1]

By G. R. Hopkins

SUMMARY OUTLINE

Whereas 1933 long will be remembered by the petroleum industry as marking the inauguration of the code and intensification of Federal supervision 1934 will go down in history as marking the first real test of the efficacy of certain theories of control, designed to accomplish various results. There is no unanimity of opinion as to the results desired, but in general the principal objectives were (1) a stable price of crude, high enough to cover more than the cost of production of the stripper wells; (2) increased employment; (3) higher and more equitable wages; (4) a balance between supply and demand, with no "distress" gasoline and disastrous price wars; (5) a minimum of waste; (6) gasoline prices high enough to provide a reasonable profit to both refiners and marketers; and (7) no "hot-oil" production.

The stable price of crude was realized in 1934, when a uniform price of $1 per barrel for 36°–36.9° gravity crude was maintained. In general, the producers were satisfied with prices, for they received nearly 50 percent more revenue in 1934 than in 1933. On the other hand, refiners without much production of their own were unable to realize a profit and clamored for either higher gasoline prices or lower crude prices.

The degree of balance between supply and demand in the petroleum industry generally is measured by the extent of the changes in stocks of crude oil and gasoline. Although the Federal allocations for both crude oil and gasoline generally were exceeded stocks of crude oil declined about 17,000,000 barrels compared with an increase of nearly 15,500,000 barrels in 1933, and stocks of finished gasoline declined 7,403,000 barrels compared with an increase of 1,509,000 barrels in 1933. These data indicate virtual fulfillment of the desire to balance supply and demand and a material improvement in the statistical position of the industry in 1934.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

Few standards are available to measure waste in the industry, but as far as physical waste is concerned there is little doubt that the higher degree of curtailment in 1934 prevented some declines in reservoir pressure and some losses by evaporation.

Although refinery prices of gasoline in 1934 were higher than in 1933 the increase was less than generally was expected. The price of gasoline to consumers, as measured by the retail price less Federal tax at 50 cities, increased about 1¼ cents (10 percent) in 1934.

The production of "hot" oil—that produced in excess of the allowables—was watched closely in 1934, chiefly as an indication of the amount of "distress" gasoline production and as a measure of the effectiveness of enforcement. Although nearly every State exceeded its allowable in 1934 the worst offender in quantity and willful intent was the east Texas field. The output of "hot" oil in east Texas fluctuated considerably in 1934, but the trend was upward until late in October, when the first Federal Tender Board was established. The estimated production of "hot" oil in east Texas in 1934 was 22,500,000 barrels compared with an excess of 48,861,000 barrels of actual production over allowables for the country as a whole.

To the list of objectives might be added elimination of unfair and uneconomic trade practices, particularly in the marketing branch of the industry. Considerable progress was made in this direction in 1934, substitution and misbranding being curtailed and "chiseling" such as the giving of secret rebates, being reduced.

From the standpoint of consumption 1934 improved materially over 1933, the domestic demand for all oils increasing from 868,488,000 barrels in 1933 to 921,440,000 barrels in 1934. The domestic demand for motor fuel, which declined materially in 1932, rose to a new high record of 406,416,000 barrels in 1934.

Field activity, as measured by the number of wells drilled, increased materially in 1934 under the stimulation of stable prices and increased demand. The number of oil wells completed increased more than 50 percent in 1934, but the average daily initial of the new wells declined from 955 barrels in 1933 to 861 in 1934. More new fields were discovered in 1934 than in 1933, but from the standpoint of new reserves the results were somewhat disappointing.

Imports for domestic consumption were restricted by a quota under the code; however, imports of fuel oil in bond increased materially. The export trade of the United States continued to be affected adversely by increased production of crude and expansion in refinery capacity abroad. Exports of crude petroleum increased, but exports of gasoline continued to decline. Total exports of refined products increased slightly in 1934 due largely to an increased movement from California to Japan.

Graphic data covering supply, demand, and prices are given in figures 59 and 60.

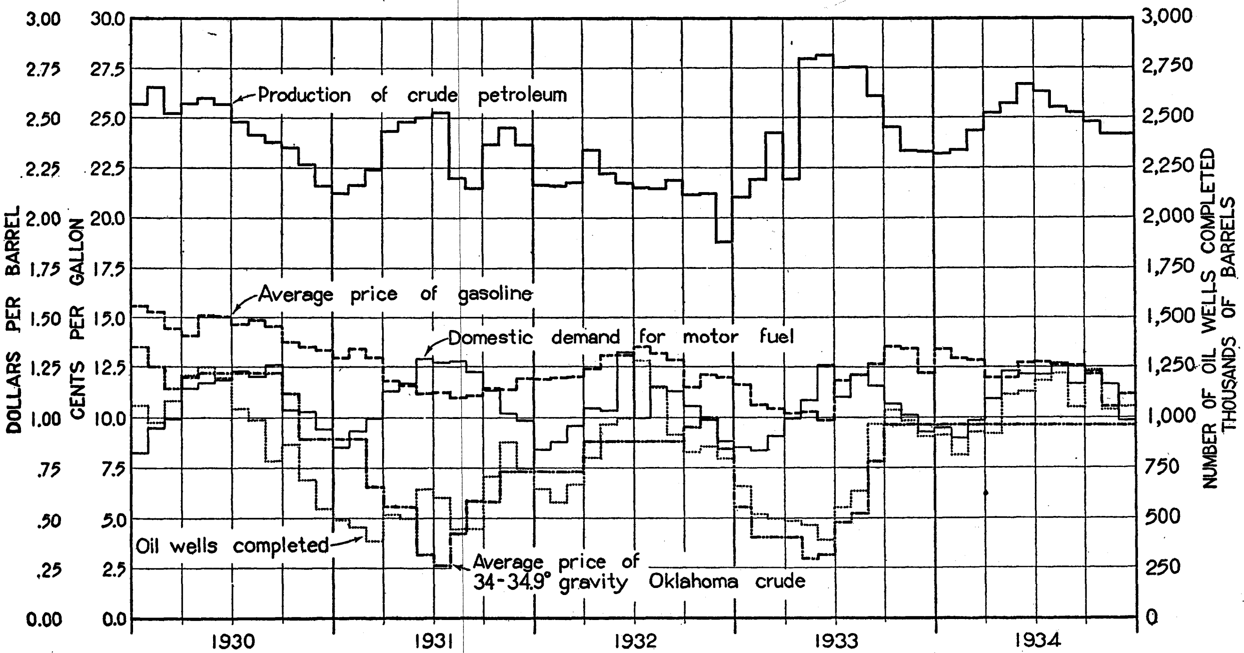

FIGURE 59.—Daily average production of crude petroleum, daily average domestic demand for motor fuel, total number of oil wells completed, average price per barrel of a selected grade of Oklahoma crude petroleum, and average tank-wagon price per gallon (excluding tax) of gasoline at 50 cities in the United States, 1930–34, by months.

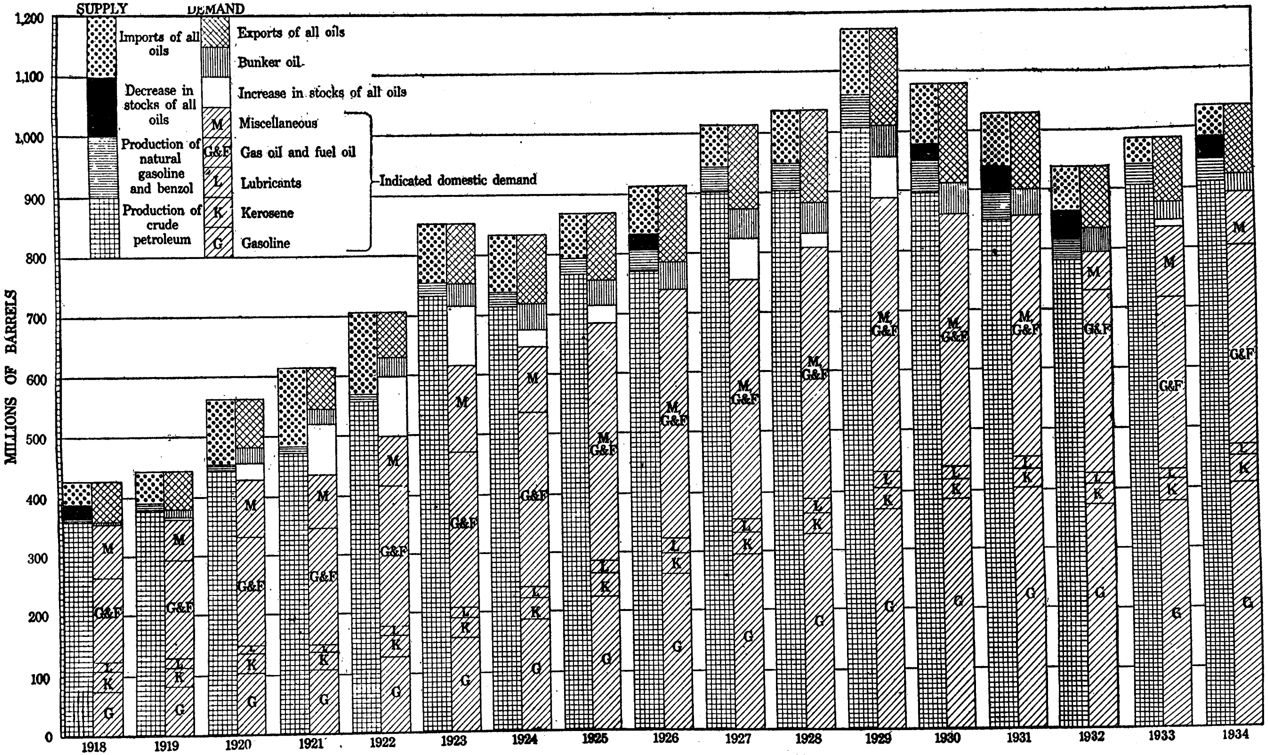

FIGURE 60.—Supply and demand of all oils, 1918–34.

Salient statistics on the supply and demand of all oils, 1933–34

[Thousands of barrels of 42 gallons]

	1933		1934 [1]	
	Total	Daily average	Total	Daily average
New supply:				
Domestic production:				
Crude petroleum	905,656	2,481	909,345	2,491
Natural gasoline	33,810	93	36,217	99
Benzol	1,368	4	1,600	5
Total production	940,834	2,578	947,162	2,595
Imports:				
Crude petroleum	31,893	87	35,558	97
Refined products	13,501	37	15,366	42
Total new supply, all oils	986,228	2,702	998,086	2,734
Change in stocks, all oils	+11,013	+30	−37,867	−104
Demand:				
Total demand, all oils	975,215	2,672	1,035,953	2,838
Exports:				
Crude petroleum	36,584	101	41,123	113
Refined products	70,143	192	73,390	201
Domestic demand:				
Motor fuel	377,003	1,033	406,416	1,113
Kerosene	38,493	105	44,223	121
Gas oil and fuel oil	316,344	867	332,286	910
Lubricants	17,152	47	18,488	51
Wax	1,263	4	855	2
Coke	9,962	27	7,538	20
Asphalt	11,808	32	13,021	36
Road oil	5,266	14	7,848	22
Still gas (production)	45,212	124	44,391	122
Miscellaneous	1,464	4	1,873	5
Losses and crude used as fuel	44,521	122	44,501	122
Total domestic demand	868,488	2,379	921,440	2,524
Stocks (end of year):				
Crude petroleum	[2] 354,305		337,254	
Natural gasoline	[2] 3,686		3,740	
Refined products	[2] 244,222		223,352	
Total stocks, all oils	[2] 602,213		564,346	
Days' supply	225		199	

[1] Subject to revision.
[2] For comparison with 1934.

REGULATION AND LEGISLATION

Minerals Yearbook, 1934, contained a discussion of code activities and legislation during 1933; the high points of 1934 may be summarized as follows:

The price-fixing program, which caused so much discussion before and after the code was formulated, was suspended indefinitely by an order of the Administrator dated January 31, 1934.

On December 7, 1933, the Planning and Coordination Committee, the industry's representative under the code, submitted for approval two agreements, the National Purchasing Agreement and the National Marketing Agreement. In brief, these were designed to stabilize gasoline prices and to assure protection to nonintegrated refiners and to various types of distributors. After an investigation the Petroleum Administrative Board amended the agreements to insure more protection to small enterprises. Meanwhile, in March 1934 the agreements were submitted to the Department of Justice for analysis and approval. On June 27, 1934, the Attorney General notified the Administrator that the Department of Justice did not approve the agreements because the Department disagreed with the theory of notice and hearing under which they were promulgated. This action and the withdrawal of a number of companies from participation virtually killed all chances for enactment of these agreements.

Price wars had been particularly severe on the Pacific coast, hence the pressure for an agreement or cartel for that area was maintained after the Department of Justice had withheld approval of the national purchasing and marketing agreements. Accordingly, a Pacific coast agreement was drafted and submitted to the Department of Justice, which, after prolonged consideration, approved it provided the participants entered into a supplemental agreement to abide by the provisions of the code and not to engage in monopolistic practices. The principal agreement, known as the Pacific Coast Petroleum Agency Agreement, became effective June 23, 1934, and was in force throughout the remainder of the calendar year.

Following the virtual failure of the two national agreements efforts were made to formulate a program so that the major companies could buy "distress" gasoline to raise the general level of wholesale gasoline prices. This effort was only partly successful, primarily because no way was devised to segregate "distress" from "hot" gasoline.

Although refinery operations had been controlled to some extent by establishing economic levels of gasoline stocks it was the consensus of opinion that the disparity between the refinery price of gasoline and the price of crude would be decreased if the output of gasoline could be coordinated with crude-oil production. Accordingly, article IV of the code was amended to provide for a program of refinery control whereby the total gasoline production is established monthly by the Federal agency and allocated to the districts and individual plants by the Planning and Coordination Committee.

An outstanding event of the year from the standpoint of regulation and enforcement was the establishment of a Federal Tender Board in the east Texas field in the latter part of October 1934. This action was based upon section 9 (c) of the National Industrial Recovery Act which in short prohibited the transportation of "hot" oil in interstate commerce. It was the duty of the Board to investigate the source of oil offered for shipment in interstate commerce to ascertain its legality—that is, whether it had been produced in accordance with the Texas proration laws. If the oil was legal a tender was issued. The plan was effective, for the estimated production of "hot" crude oil declined from 130,000 barrels daily when the Board arrived in east Texas to 5,000 barrels daily on December 31. (See fig. 61.) Section 9 (c) of the National Industrial Recovery Act was invalidated by the United States Supreme Court on January 7, 1935, and the Federal Tender Board withdrew pending passage of a valid law.

The year 1934 was comparatively unproductive of permanent legislation affecting the oil industry. As regards Federal legislation, most of the interest centered in the so-called Thomas-Disney bill, a joint bill sponsored by Senator Elmer Thomas and Congressman W. E. Disney, both of Oklahoma. In brief, the Thomas-Disney bill provided for Federal control of crude-oil production by establishing quotas in commerce. When the bill was before the House Ways and Means Committee it appeared to have an excellent chance of passing; but opposition from various quarters, particularly from Texas, plus the imminence of adjournment, proved too much of an obstacle, and the bill was not passed. Instead a resolution was passed to conduct a thorough investigation of the industry so that complete information would be available for use at the next session. Considerable oil legislation was passed by the State legislatures in 1934, but little had national significance. As the year closed some States were studying the theory of interstate compacts, which had been revived as an alternative for Federal control.

State allowables for crude-oil production were established by the Federal agency for each month of 1934 except those for February, which were unchanged from January, and May, which were the same

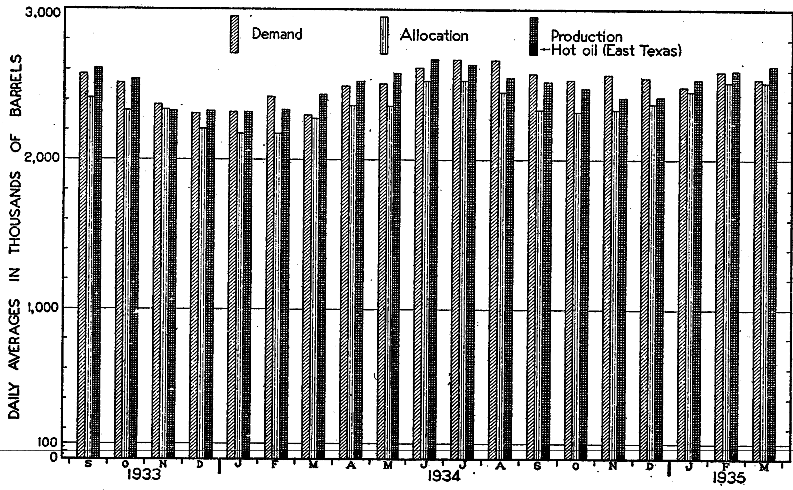

FIGURE 61.—Daily average demand for domestic crude, daily average Federal allocation for the United States, daily average production of crude petroleum, and estimated "hot-oil" production in East Texas from the beginning of the code in September 1933 through March 1935, by months.

as for April. National allowables for gasoline production were established for every month, beginning with June. In the absence of the power to make the allowables for crude oil mandatory on the States the actual production for the majority of the States was generally above the allowables; in fact, only five States—Arkansas, Illinois, Michigan, Ohio, and West Virginia—produced less than they were allowed in 1934. The excess production for the country as a whole in 1934 was 48,861,000 barrels, equivalent to 5.4 percent of the actual output. In spite of the excess production stocks of crude declined 17,000,000 barrels, a fact generally overlooked by those contending that the allocations have been too high.

CRUDE PETROLEUM

Supply and demand.—The new supply—production plus imports—of crude petroleum in 1934 was only about 1 percent higher than in 1933, but total demand increased about 40,000,000 barrels (between 4 and 5 percent). The apparent deficiency in supply was obtained from stocks, which declined about 17,000,000 barrels compared with an increase of nearly 15,500,000 barrels in 1933.

The total demand for crude petroleum in 1934 was 961,954,000 barrels, comprising 895,636,000 barrels run to stills, 41,123,000 barrels exported, and 25,195,000 barrels used as fuel or lost in handling.

Supply and demand for crude petroleum, 1933–34

[Thousands of barrels of 42 gallons]

	1933	1934
Production	905,656	909,345
Imports	31,893	35,558
Decrease in stocks		17,051
Total new supply plus decrease in stocks	937,549	961,954
Runs to stills:		
Domestic	825,786	860,776
Foreign	35,468	34,860
Total runs to stills	861,254	895,636
Exports	36,584	41,123
Increase in stocks	15,437	
Losses and crude used as fuel	24,274	25,195
Total demand plus increase in stocks	937,549	961,954

PRICES AND VALUES

Since the earliest days of the petroleum industry producers have hoped for a stable and, of course, high price for oil. This wish was realized in 1934 as far as the stability was concerned, and although the estimated average price of 99 cents per barrel probably was considerably below the hopes of those who received $4 and $5 a barrel for crude just after the war the increase in revenue from $608,000,000 in 1933 to $900,000,000 in 1934 was gratifying. On the other hand, refiners were not particularly pleased with dollar crude in 1934 as in general, the prices they received for gasoline were comparatively low. In consequence, threats of purchasers to reduce the price were recurrent, the most serious being forestalled by the Federal Tender Board.

The price of 36°–36.9° gravity crude in Oklahoma, the grade generally accepted as the standard, was $1 throughout the year. The price of Bradford crude, a premium eastern crude, was $2.45 on January 1, rose to $2.55 on May 1, declined to $2.30 on November 6, and dropped to $2.05 on December 6. Relatively few changes in crude-oil prices were made in 1934, despite repeated assertions that the price was being maintained at an artificially high figure.

The price trends of representative grades of crude petroleum over a period of years are shown graphically in figure 62.

CONSUMPTION AND DISTRIBUTION

Runs to stills.—Crude runs to stills, which ordinarily constitute about 90 percent of the total demand, totaled 895,636,000 barrels in 1934, an increase of 4 percent over 1933. Of the total in 1934, 34,860,000 barrels (4 percent) were foreign crude and 860,776,000 barrels (96 percent) domestic crude, indicating a further decrease in the relative proportion of foreign crude utilized.

The outstanding changes in crude runs by districts in 1934 as compared with 1933 were increased runs in the Gulf Coast, compensated by decreases in the Oklahoma-Kansas-Missouri district and in California. The Texas Gulf Coast was the leading district in crude runs to stills in 1934; in 1933 it ranked second; in 1932, third.

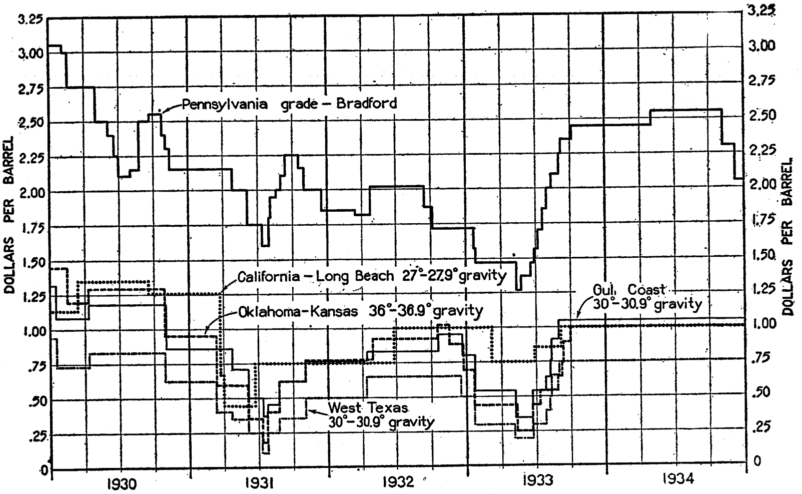

FIGURE 62.—Posted prices of selected grades of crude petroleum, 1930–34, by months.

Crude runs to stills, 1932–34, by districts

District	1932 Thousands of barrels	1932 Percent of total	1933 Thousands of barrels	1933 Percent of total	1934 Thousands of barrels	1934 Percent of total
East Coast	162,534	20	166,932	19	171,733	19
Appalachian	34,136	4	33,567	4	35,809	4
Indiana, Illinois, Kentucky, etc.	106,758	13	117,073	14	119,166	13
Oklahoma, Kansas, and Missouri	87,170	11	96,541	11	95,006	11
Texas inland	49,435	6	57,454	7	61,941	7
Texas Gulf Coast	147,143	18	160,691	19	179,418	20
Louisiana Gulf Coast	35,853	4	39,034	4	41,341	5
Arkansas and Louisiana inland	18,297	2	18,485	2	18,850	2
Rocky Mountain	13,934	2	14,209	2	16,037	2
California	164,737	20	157,268	18	156,335	17
	819,997	100	861,254	100	895,636	100

Distribution.—An analysis of total crude-oil distribution for 1934 indicates that the new supply was 944,903,000 barrels, comprising 909,345,000 barrels produced and 35,558,000 barrels imported. Withdrawals of crude from storage totaled 17,051,000 barrels, hence the total demand was 961,954,000 barrels. Of this total 895,636,000 barrels were run to stills, 41,123,000 barrels were exported, and 25,195,000 barrels were used as fuel or lost in handling. Receipts of crude at refineries totaled 898,006,000 barrels, of which 494,403,000 barrels (55 percent) came from intrastate sources, 368,045,000 barrels (41 percent) from interstate sources, and 35,558,000 barrels (4 percent) from foreign countries. Comparable data are available for only the last 4 months of 1933, but the indications are that the relative proportion of receipts from foreign sources increased in 1934 but that of interstate receipts remained unchanged.

Production in Arkansas in 1934 was 11,139,000 barrels, of which about half moved interstate to Louisiana and Texas and the other half moved intrastate to local refineries. In addition, 1,711,000 barrels of East Texas crude were received at refineries in Arkansas in 1934.

Production in California in 1934 was 175,509,000 barrels, none of which moved to other States. The demand for crude in California is divided approximately as follows: 89 percent for refining, 7 percent for export, and 4 percent for fuel and losses.

No material change occurred in crude-oil distribution in Colorado in 1934. The consumption at the few small refineries in that State about equals production with receipts by tank car from New Mexico and Wyoming of about 1,000 barrels daily, roughly balancing shipments to Utah.

The data for Georgia, South Carolina, and Virginia are combined in the statistics of distribution in order not to disclose the operations of individual refineries. These States have no production and no pipe lines, hence their refineries are supplied by water-borne crude. The refineries in South Carolina use only foreign crude, and the refineries in Georgia use both foreign crude and crude from Texas. In 1934 receipts of foreign crude at refineries in the three States totaled 1,930,000 barrels; receipts from Texas were 1,712,000 barrels.

Illinois refineries received about 30,000,000 barrels of crude oil from eight States in 1934; in addition, nearly all the Illinois production of 4,452,000 barrels was consigned to local plants. Occasional shipments were made to Michigan and to Canada. Most of the interstate receipts were from Oklahoma.

The distribution of crude oil in Indiana is similar to that in Illinois. The heavy refinery demand is supplied mainly from Oklahoma and Kansas, with the small production within the State about balancing the movement to other States.

Production in Kansas in 1934 was 46,555,000 barrels, of which about a third moved to Illinois, Indiana, Missouri, Oklahoma, and Pennsylvania. Receipts from Oklahoma and Texas are approximately half of the interstate deliveries. The refineries in Kansas processed approximately 100,000 barrels daily in 1934. The small production in Missouri is used principally for fuel, hence the refinery requirements of about 5,000,000 barrels in 1934 were supplied from outside sources—Kansas, Oklahoma, and Texas.

Kentucky refines more crude than it produces, and the balance is supplied principally by receipts from Oklahoma. About 2,000 barrels of Kentucky crude move daily to Illinois and West Virginia.

In 1934 refineries in Louisiana and Alabama processed 52,639,000 barrels, including 41,341,000 barrels refined at coastal plants. As supply in Louisiana in 1934 was just over 32,400,000 barrels, and deliveries to other States were about 18,000,000 barrels it follows that nearly 40,000,000 barrels were brought into the State from outside sources.

Maryland, like several States on the Atlantic seaboard, has no production, the requirements of the few plants there being supplied by imports and receipts from New Mexico and Texas.

The few refineries in Massachusetts and Rhode Island normally handle foreign crude and mixtures of crude from New Mexico and west Texas.

Production in Michigan in 1934 (10,708,000 barrels) was more than enough to take care of crude runs at refineries within the State (7,232,000 barrels); nevertheless, due to intercompany alinements and other factors about half of the production in 1934 was shipped to other States, principally Ohio, and nearly half the refinery requirements within the State were supplied by Oklahoma crude.

Montana, like Michigan, receives crude from outside sources, although production is more than ample to take care of refinery demand within the State. Practically all shipments from Montana are to Canada.

Crude runs to stills at refineries in New Jersey in 1934 totaled 64,249,000 barrels—about 50,000,000 barrels from interstate sources and the remainder from foreign countries. Most of the crude used in New Jersey is received by boat, although the two pipe lines that enter the State from the West brought in about 12,000 barrels daily in 1934.

Because of contiguity, company alinements, and similarity in quality the crude from southeast New Mexico generally is handled with that from west Texas; that is, most of it is moved by pipe line to the Gulf for refining or tanker movement to the East coast. The ratio of interstate shipments to intrastate shipments is higher for New Mexico than for any other State.

Production in New York fills only a fraction of its crude-oil requirements; the balance is supplied by imports and receipts from other States. In 1934 imports averaged nearly 10,000 barrels daily, whereas other receipts, principally from Texas, were about 17,000 barrels daily.

Ohio produces only a small part of its refinery requirements; the rest is received from other States, principally Oklahoma.

Oklahoma is second only to Texas in interstate shipments of crude oil; about two-thirds of the production moves to other States. In addition, exports to Canada average nearly 20,000 barrels daily.

Pennsylvania ranks third among the States in crude runs to stills. Most of the production, which averages about 40,000 barrels daily, is refined in the western part of the State. The few large plants on the Atlantic seaboard receive most of their crude from Texas.

The movement of crude from Texas to refineries in other States in 1934 totaled 170,940,000 barrels, equivalent to 45 percent of the State production and 46 percent of total interstate deliveries. Texas also leads in diversity of shipments; in fact, most of the refining States received some crude from Texas in 1934. In spite of the apparent overabundance of crude in Texas receipts from other States normally average well over 100,000 barrels daily; this business is partly based on quality considerations, although intercompany relationships are the chief factor.

Refineries in Utah received about 2,000,000 barrels of crude by tank car from four States in 1934.

Production in West Virginia about equals consumption. The refineries in the State receive oil from Kentucky, Ohio, and Oklahoma, the total receipts being slightly higher than deliveries to New Jersey, Ohio, and Pennsylvania.

Production in Wyoming exceeds refinery requirements by about 50 percent; the balance goes to Colorado, Montana, and Utah and also is used for fuel within the State.

Distribution of crude petroleum in 1934, by States

[Thousands of barrels of 42 gallons]

State	Production	Imports	Refinery receipts from other States		Runs to stills	Exports [1]	Deliveries to refineries in other States		Fuel and losses	Change in total crude stocks by location
			Quantity	State			Quantity	State		
Arkansas	11,139		1,711	Texas	7,552		5,701	Indiana, Louisiana, Texas	1,336	−1,739
California	175,509				156,335	11,254			6,270	+1,650
Colorado	1,162		440	New Mexico, Wyoming	1,098		225	Utah	57	+122
Georgia		353	1,712	Texas	[2] 3,514				[2] 11	[2] +117
Illinois	4,452		30,333	Indiana, Kansas, Kentucky, Louisiana, Michigan, New Mexico, Oklahoma, Texas.	33,541	464	404	Michigan	609	−233
Indiana	810		54,559	Arkansas, Kansas, Louisiana, Michigan, New Mexico, Oklahoma, Texas.	54,781		796	Illinois, Kentucky	115	−323
Kansas	46,555		8,697	Oklahoma, Texas	36,668	47	15,691	Illinois, Indiana, Missouri, Oklahoma, Pennsylvania.	4,417	−1,571
Kentucky and Tennessee	4,862		2,182	Indiana, Oklahoma	6,545	10	597	Illinois, West Virginia	18	−126
Louisiana	32,294	1,335	[3] 38,844	Arkansas, Oklahoma, Texas	[3] 52,639		18,150	Illinois, Indiana, New Jersey, Ohio, Pennsylvania, Texas.	3,099	[3] −1,415
Maryland		2,707	9,397	New Mexico, Texas	12,029				54	+21
Massachusetts		1,578	[4] 12,546	do	14,651				[4] 13	[4] −74
Michigan	10,708		3,305	Illinois, Oklahoma	7,232	321	5,396	Illinois, Indiana, Ohio	1,344	−280
Missouri			5,046	Kansas, Oklahoma, Texas	5,021				[5] 154	[5] −129
Montana	3,786		1,361	Wyoming	2,922	1,722	16	Wyoming	35	+452
New Jersey		14,192	50,509	Louisiana, New Mexico, New York, Oklahoma, Pennsylvania, Texas, West Virginia.	64,249				26	+426
New Mexico	16,915		202	Texas	1,318		16,241	Colorado, Illinois, Indiana, Maryland, Massachusetts, New Jersey, Pennsylvania, Texas, Utah.	−541	+99
New York	3,800	3,342	6,109	Oklahoma, Pennsylvania, Texas	13,587		289	New Jersey, Pennsylvania	176	−801
Ohio	4,232		23,009	Louisiana, Michigan, Oklahoma, Texas, West Virginia.	26,463	65	1,251	Pennsylvania, West Virginia	268	−806
Oklahoma	180,624		2,532	Kansas, Texas	53,317	6,908	123,304	Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Missouri, New Jersey, New York, Ohio, Pennsylvania, Texas, West Virginia.	1,042	−1,415
Pennsylvania	14,516	7,733	67,091	Kansas, Louisiana, New Mexico, New York, Ohio, Oklahoma, Texas, West Virginia.	86,295		4,059	New Jersey, New York	−1,659	+645
Rhode Island		466	(4)	Texas	(4)				(4)	(4)
South Carolina		543			(2)				(2)	(2)

Texas	380,820	2,275	43,721	Arkansas, Louisiana, New Mexico, Oklahoma.	241,359	20,188	170,940	Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Louisiana, Maryland, Massachusetts, Missouri, New Jersey, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, Utah.	5,730	−11,401
Utah			2,111	Colorado, New Mexico, Texas, Wyoming.	2,098				1	+12
Virginia		1,034			[2]				[2]	[2]
West Virginia	4,096		2,612	Kentucky, Ohio, Oklahoma	3,821		1,685	New Jersey, Ohio, Pennsylvania	1,498	−296
Wyoming	13,065		16	Montana	[6] 8,601	144	3,200	Colorado, Montana, Utah	1,122	+14
Total	909,345	35,558	368,045		895,636	41,123	368,045		25,195	−17,051

[1] Includes shipments to Alaska, Hawaii, and Puerto Rico.
[2] Georgia includes South Carolina and Virginia.
[3] Includes Alabama.
[4] Massachusetts includes Rhode Island.
[5] Missouri includes Iowa.
[6] Includes Nebraska and South Dakota.

STOCKS

The trend in crude-oil stocks, which was decidedly upward in the middle of 1933 but which turned downward following the enactment of the code, was generally downward in 1934. Total stocks of refinable crude on hand at the close of 1934 were 337,254,000 barrels, indicating a total withdrawal of 17,051,000 barrels for the year compared with an increase of 15,437,000 barrels in 1933.

Stocks of crude in California increased slightly in 1934, hence all the decrease was recorded east of California. Stocks of foreign crude and stocks held on the leases showed small increases in 1934, and refinery stocks declined about 2,000,000 barrels, hence the major portion of the decline was registered in tank-farm stocks. More specifically, most of the decline was in stocks of east Texas crude, a

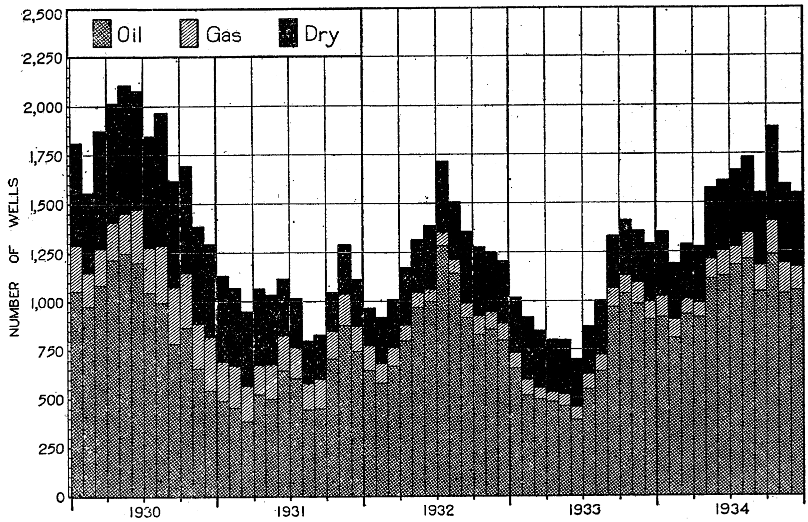

FIGURE 63.—Wells drilled, 1930–34, by months.

crude much desired by refiners because of its high gasoline content and low refinery costs.

WELLS

According to an estimate by Dr. N. D. Fitzgerald of the Petroleum Administrative Board the number of oil wells on December 31, 1934 was 335,000. As there were 326,850 producing wells at the beginning of the year and as 12,512 oil wells were brought in during the year, it may be inferred that about 4,400 wells were abandoned in 1934.

Approximately 50 percent more wells were drilled in 1934 than in 1933, the total increasing from 12,312 in 1933 to 18,197 in 1934. Of the completions in 1934, 12,512 (69 percent) were oil wells, 1,373 (7 percent) gas wells, and 4,312 (24 percent) dry. These data indicate a further gain in the percentage of oil wells, with a corresponding decline in the number of dry holes. The continued increase in the proportion of successful completions reflects improvements in the application of geology and geophysics and in drilling technique. The reduction in the ratio of dry holes in 1933 was due essentially to the fact that a large part of the completions of that year were on inside locations in the east Texas field; on the other hand, the decrease in the dry-hole ratio in 1934 was due primarily to increased activity in the Bradford-Allegany district, notable for its lack of barren spots, as well as to more successful drilling elsewhere. Furthermore, the new pool plan of the Petroleum Administration, by limiting drilling over the entire year of 1934, automatically reduced the number of semi-wildcats, most of which would have been dry.

East Texas again was the leading district in drilling in 1934, with Bradford-Allegany second. Conroe, which was third in completions in 1933, fell to about tenth place, being succeeded by Archer County, Tex.

The total number of wells completed, divided as between oil wells, gas wells, and dry holes, is shown graphically in figure 63.

Drilling activity in leading districts, 1933–34

District	State	Completions [1]		District	State	Completions [1]	
		1933	1934			1933	1934
Archer County	Texas	346	963	Ohio County	Kentucky	50	256
Bradford-Allegany	Pennsylvania-New York.	929	1,414	Oklahoma County	Oklahoma	70	65
Conroe	Texas	615	182	Osage County	do	88	320
Creek County	Oklahoma	187	236	Pontotoc County	do	47	115
Duval County	Texas	233	451	Pottawatomie County.	do	61	128
East Texas	do	2,467	3,517	Rice County	Kansas	51	121
Glacier County	Montana	44	116	Sabine Parish	Louisiana	189	170
Gray County	Texas	128	209	Seminole County	Oklahoma	82	106
Greta	do	94	119	Tomball	Texas	33	111
McPherson County	Kansas	142	126	Ward County	do	104	130
Midland County	Michigan	190	221	Young County	do	285	342

[1] Totals for oil wells, gas wells, and dry holes.

PRODUCTION BY STATES

The production of crude petroleum in 1934 was relatively steady throughout the year, the fluctuations being much less pronounced than in 1933. The highest daily average production attained in 1934 was about 2,700,000 barrels and the lowest about 2,300,000 barrels, a deviation of only 8 percent from the average. The principal factor contributing to the increased steadiness in production in 1934 was the allocation program of the Federal Government, which was in effect all the year compared with only 4 months in 1933. The Federal allocations showed changes from month to month, conforming somewhat to seasonal changes in demand, but extreme fluctuations were avoided by regulating additions to or withdrawals from stocks.

Texas easily retained its rank as the leading producing State, its output being 41.9 percent of the national total compared with 44.5 percent in 1933. The rank of the remaining States showed remarkably little change in 1934, the only change being the displacement of Arkansas in eighth place by Wyoming, which ranked ninth in 1933.

The relative importance of the various States in crude-oil production is shown graphically in figure 64.

In 1934, 5.2 percent of the output of crude petroleum was produced east of the Mississippi, 64.3 percent in the Mid-Continent, 9.2 percent on the Gulf, 2.0 percent in the Rockies, and 19.3 percent in California. These data indicate an increase in the relative proportion of every district except the Mid-Continent. This marked a reversal in the general trend toward centralization in the Mid-Continent, which started with Seminole in 1927 and was accentuated following the discovery of the east Texas field. Production of Pennsylvania grade crude oil, a premium crude from New York, Pennsylvania, West Virginia, and parts of Ohio, increased in 1934 under the stimulus of increased demand and higher prices.

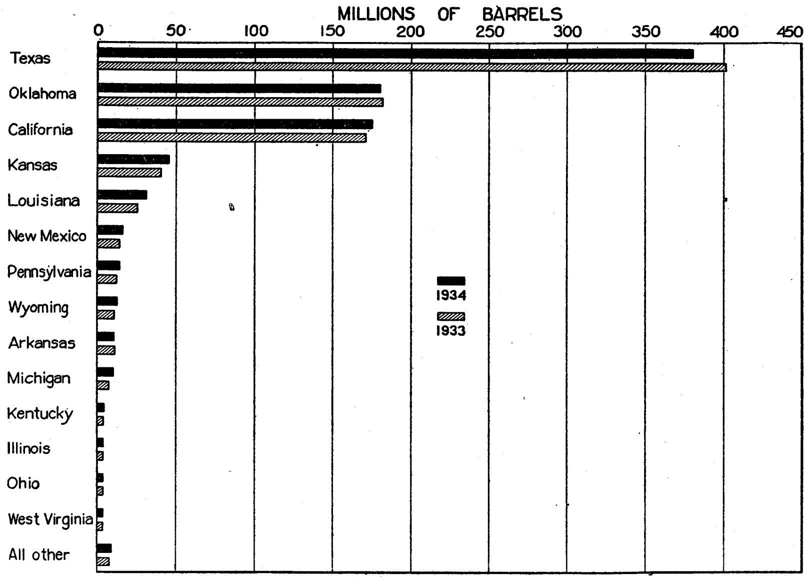

FIGURE 64.—Production of crude petroleum, 1933–34, by States.

Production of crude oil in leading fields, 1934, in barrels

Field	Production in 1934	Approximate increase or decrease compared with 1933
East Texas, Tex	181, 143, 000	−23, 811, 000
Oklahoma City, Okla	63, 011, 000	−5, 301, 000
Seminole, Okla	38, 247, 000	−3, 185, 000
Long Beach, Calif	23, 067, 000	−1, 328, 000
Kettleman Hills, Calif	21, 394, 000	−245, 000
Midway-Sunset, Calif	19, 713, 000	+2, 201, 000
Conroe, Tex	17, 143, 000	−4, 072, 000
Yates, Tex	16, 443, 000	−4, 280, 000
Huntington Beach, Calif	15, 106, 000	+2, 132, 000
Bradford, Pennsylvania-New York	14, 924, 000	+2, 562, 000
Santa Fe Springs, Calif	14, 722, 000	−3, 507, 000
Van, Tex	14, 633, 000	−2, 444, 000
Hobbs, N. Mex	12, 438, 000	+895, 000
McPherson, Kans	9, 897, 000	−1, 866, 000
Salt Creek, Wyo	6, 489, 000	−520, 000
All other	440, 975, 000	+46, 458, 000
	909, 345, 000	+3, 689, 000

Arkansas.—Field activity increased materially in Arkansas in 1934, but the new production did not compensate for the well-established decline in the El Dorado and Smackover fields, and production accordingly decreased from 11,686,000 barrels in 1933 to 11,139,000 barrels in 1934. One new field, Rainbow, in Union County, was discovered in November and was being developed actively as the year closed.

California.—In 1934, for the first time in several years, the annual production of crude oil in California increased, the total reported by the American Petroleum Institute being 175,509,000 barrels compared with 172,010,000 barrels in 1933.

Field activity increased materially in California, and the number of oil wells completed rose from 248 in 1933 to 452 in 1934. This gain in development work resulted from a desire of many operators to replenish their diminishing reserves as well as from a general inclination to make the most of improved marketing conditions. The fields exhibiting the largest increases in activity in 1934 were Kettleman Hills, Mountain View, Santa Barbara, and Long Beach. One new field, Edison, was discovered in 1934; it is just east of the Mountain View field in Kern County. Eleven oil wells and six dry holes were drilled at Edison in 1934, enough to prove the field small and relatively unimportant. Results of efforts to extend the deep zone discovered at Montebello in 1933 were disappointing. In brief, drilling in California in 1934 increased the State's potential materially but the reserves only slightly.

Crude-oil prices remained unchanged in California in 1934, but gasoline prices improved following the establishment of the Pacific Coast Petroleum Agency in June. The agency works under an agreement, which in part stipulates that members can sell their surplus gasoline to the agency at going prices provided they do not run "hot" crude. The fuel-oil market in California was considerably strengthened by the heavy movement to the East coast.

Colorado.—Production in Colorado increased materially, and the total for 1934—1,162,000 barrels—was 26 percent higher than in 1933 and slightly above the level of 1932. All this increase was registered at Iles as the output of all the other fields declined. Seven oil wells were completed in Colorado in 1934 compared with 3 in 1933; all completions in 1934 were in Moffat County. Several interesting wildcats were drilled in the State in 1934; the principal discovery was the finding of oil in the Tertiary in the Hiawatha gas field.

Illinois.—Although only six oil wells were completed in Illinois in 1934 the production increased from 4,244,000 barrels in 1933 to 4,452,000 barrels in 1934. This gain reflected the stabilized price, although improved methods of recovery (such as water-flooding and repressuring) may have had some influence on production.

Indiana.—The expected increase in field activity predicted for Indiana on the basis of leasing in 1933 materialized, and 69 oil wells were completed compared with 52 in 1933. Production accordingly rose from the low point of 737,000 barrels in 1933 to a total of 810,000 barrels in 1934. About half the successful completions in 1934 were in Vanderburgh and Gibson Counties, but the development work extended over more than a dozen counties.

Kansas.—Despite a better than average adherence to Federal allocations in the face of a potential several times the allowable, production in Kansas established a new record in 1934. The total output in 1934 was 46,555,000 barrels compared with 41,976,000 barrels in 1933 and with the previous record of 45,451,000 barrels in 1918. In general, production in Kansas increased slowly and steadily throughout the year, the daily average in January 1934 being 110,000 barrels but rising to 137,000 barrels in January 1935.

Kansas is unique among the leading producing States in that the oil comes from many small pools, none of which is particularly outstanding. It appears, however, that the Ritz-Canton and Hollow fields continued to rank first and second, respectively, in production.

Field work, which had appeared active in 1933 increased materially in 1934. The total number of oil wells brought in during 1934 was 591 out of 835 completions; the total initial of the successful completions was approximately 300,000 barrels, an average of just over 500 barrels per well per day. McPherson County led in drilling, but Reno County, with its flush Haury-Burrton field, was first in initial.

As might logically be expected from the increase in drilling, numerous discoveries were made in Kansas in 1934. Although most of the new fields were virtually untested as the year closed State reserves were increased substantially. The most important find of the year was the discovery of a rich Hunton zone in the Haury-Burrton field in March. Later a well in this field found substantial production in the deeper Siliceous lime. Before the Hunton discovery the field had been producing from the "chat," hence as the year closed this field had three distinct horizons from which to draw. Important among the other discoveries were the Russell pool, Russell County; the Hilger, Reno County; the Graber, McPherson County; and the Geneseo, Rice County. Barber County was added to the list of producing counties as part of the general westward march of production. More and more reliance was placed on the use of acid in completing wells in Kansas, and the potential of the completions was much higher than it would have been if methods of 5 to 10 years ago had been used.

Kentucky.—The optimistic tone that pervaded the producing branch of the industry in 1934 was quite pronounced in Kentucky, and drilling increased nearly 100 percent over 1933. The total output accordingly rose from 4,608,000 barrels in 1933 to 4,851,000 in 1934. Ohio County, in the western part of the State, claimed the major portion of the attention, 175 oil wells being brought in there out of 236 for the State.

Louisiana.—Production increased materially in Louisiana in 1934, and although the total of 32,294,000 barrels fell somewhat short of the record established in 1920 it represented an increase of 28 percent over 1933. As has been the case in recent years, all of the gain in output was in the coastal fields, and the older fields in the northern part of the State continued to decline. In 1934 the coastal district yielded 23,249,000 barrels, which was more than 50 percent higher than the total in 1933.

Drilling activity increased in northern Louisiana in 1934, when 139 oil wells were brought in compared with 102 in 1933; however, the average initial of the completions in 1934 was considerably less than the average in 1933, which probably had some bearing on the decreased production in the area. Wildcatting persisted on the Sabine uplift, with a few new gas horizons as about the only reward. Deep tests to the Trinity sand continued to prove disappointing. The number of dry holes drilled in northern Louisiana in 1934 considerably exceeded the oil wells completed, a tribute to the faith and persistence of the wildcatters of that district.

Iowa continued to be the leading producing field in the coastal district of Louisiana, although the Leesville field showed a much larger increase in 1934. The other fields which may be credited with a large part of the gain in production in coastal Louisiana in 1934 were Caillou Island and the new fields, Bosco and Roanoke. Development of domes indicated by geophysical prospecting continued, and several new fields were opened; in addition to Bosco and Roanoke the most promising were Four Isle and Gillis. Practically all of the new fields produce from deep sands, 8,000- to 9,000-foot wells being common.

Michigan.—Michigan continued to surprise those who never believed it would become an important oil-producing State by making another material gain in output in 1934. The total production in 1934 was 10,708,000 barrels compared with 7,942,000 barrels in 1933. In spite of the material increase in potential in 1934, with many 10,000-barrel wells being completed in the Porter field, production was kept under control; in fact, Michigan was one of the few States to produce less than the Federal allowable in 1934.

Development work was pushed in Michigan in 1934, and 272 oil wells were completed compared with 218 in 1933 More than two thirds of the new oil wells and about 95 percent of the initial production were credited to Midland County. More specifically, the major portion of the successful drilling was in the Porter field, which may be considered an extension of the old Mount Pleasant field.

Wildcatters were active in Michigan in 1934, and several new fields were opened up. Of these the pool in Beaverton Township, Gladwin County, appeared to have the most promise as the year closed.

Montana.—Production in Montana in 1934 was 3,786,000 barrels, which was notable both because it was the highest total since 1929 and because it represented the largest relative increase for any State compared with production in 1933. The Cut Bank field contributed the most of the new production in 1934 and was the scene of most of the development work. This field was greatly extended during the year and is now approximately 20 miles long and several miles wide. The majority of the other fields declined in output in 1934, a notable exception being the old Kevin-Sunburst field, which continued as the ranking field of the State, despite the shift of interest to Cut Bank.

New Mexico.—Production established a new record in New Mexico in 1934, when the output was 16,915,000 barrels compared with 14,116,000 barrels in 1933 and with the previous record total of 15,227,000 barrels in 1931. New Mexico ranked sixth among the producing States in 1934, whereas 5 years before it was in seventeenth place.

Drilling increased substantially in New Mexico in 1934, when 107 oil wells were brought in compared with 45 in 1933. Most of the initial production added in 1934 was from wells in the southeast corner of the State; in fact, the fields in the northwest (San Juan and McKinley Counties) produce only about 2 or 3 percent of the State total. Of major importance was the completion of large wells in the Cooper field, Lea County; it had been thought to be only a gas field. The Eunice and Jal fields were developed quite actively, and production of each increased materially. Drilling at Hobbs was confined mainly to edge wells, but the potential for the field was increased materially by acidization of the old wells. Hobbs was credited with about 75 percent of the State production in 1934 compared with about 80 percent in 1933.

Ohio.—Production in Ohio remained virtually unchanged, the total for 1934 of 4,232,000 barrels being only 3,000 barrels below that of 1933. Drilling was confined to routine completions in the old fields, with little attempt to find new pools; however, in number of wells completed Ohio was outranked by only Oklahoma, Pennsylvania, and Texas in 1934.

Oklahoma.—Production in Oklahoma was curtailed more effectively in 1934 than in 1933, with the result that the total declined from 182,251,000 barrels in 1933 to 180,624,000 barrels in 1934. Oklahoma City, the leading field of the State, showed definite signs of being on the down grade, its output decreasing from 68,312,000 barrels in 1933 to 63,011,000 barrels in 1934. Possibly this decline may have been due to a successful drive against "hot-oil" operations, but it is the general consensus of opinion that the Oklahoma City field was ruined in its youth and will never again be the "threat to stability" that it was in 1932 and 1933. The Seminole district, the cradle of many of the first proration plans, demonstrated again that it is still a substantial producer; its output in 1934 was 38,247,000 barrels, or only about 3,000,000 barrels below 1933. Production in the other fields of the State reflected the development of new pools, as well as leniency shown the stripper areas in curtailment orders, and gained in output in 1934.

Oklahoma, like Kansas, was favored with an unusually high number of new discoveries in 1934. According to the Oil and Gas Journal 31 new oil and gas pools were opened in the State in 1934. However, most of the new discoveries were small; in fact, if it had not been for Fitts, the reserves discovered in 1934 only would have compensated for a fraction of the oil withdrawn. Only two of the new pools developed in Oklahoma in 1934 were considered of major importance; these were Fitts in Pontotoc County and South Burbank in Osage County. The Fitts pool was discovered in 1933; the first wells were comparatively small, erratic producers, and it was not until the deeper Wilcox zone was found that the field assumed a position of importance. The other major discovery, the South Burbank field, is, as the name indicates, south of the old Burbank field. The wells at South Burbank do not have as high initials as those at Fitts, but the crude is of high quality and much desired by refiners of lubricating oils. Other new discoveries which made their presence felt in production were Polo, Noble County, and Wilzetta, Lincoln County. The Lucien and Crescent fields, which aroused much interest in 1933, were developed actively in 1934 with moderate success.

The stable price and the desire of many companies to increase their reserves were the principal influences that spurred field activity in Oklahoma to the greatest height in several years. The number of oil wells completed rose from 668 in 1933 to 1,161 in 1934; the increase was even more evident from the standpoint of new production, as the total daily initial of the completions in 1934 (674,000 barrels) was more than double that of 1933. The leading counties in drilling in 1934 were Osage, Creek, and Pontotoc.

Pennsylvania.—Production in Pennsylvania in 1934 totaled 14,516,000 barrels, the highest since 1898. Drilling was more active than in several years, about 1,450 oil wells being brought in compared with about 950 in 1933. The Bradford field, with its extensive water floods, continued to dominate production in Pennsylvania, having roughly two-thirds of the oil wells completed and nearly 80 percent of the State output in 1934. Compared with 1933 these data indicate a gain in the relative importance of the Bradford field as a producer.

The price of Bradford crude, which had reached a low point of $1.27 in May 1933 but had increased to $2.45 by January 1, 1934, remained virtually unchanged until November, when a cut of 25 cents was made; the average for the year was $2.46 compared with $1.86 in 1933. As the average cost of producing crude in Pennsylvania is about $2 a barrel it is evident that the producers were able to turn losses into profits in 1934 and were financially able to drill more wells.

Tennessee.—Production in Tennessee increased from 5,000 barrels in 1933 to 11,000 barrels in 1934. Most of this gain was due to higher estimates for unreported production.

Texas.—The output of crude oil in Texas in 1934 totaled 380,820,000 barrels, a decrease of about 22,000,000 barrels from 1933. The chief cause of this decline was a relatively higher degree of enforcement in east Texas; in fact, production outside of east Texas showed a slight increase. Production in the Texas Gulf coast declined slightly in 1934, more from the effects of proration than from a lower potential. On the other hand, the decrease in production in west Texas in 1934 probably was related to the natural decline of the wells in that area.

Higher allowables and increased drilling were the chief factors underlying an increase in production in the Texas Panhandle—from 16,673,000 barrels in 1933 to 20,290,000 barrels in 1934. There were 435 completions in the Panhandle in 1934, of which 58 were gas wells and only 24 dry holes. Possibly because of a growth in the use of acid the oil wells completed in 1934 had a much higher average initial than in 1933. Gray County was again the most active area in the Panhandle, though Wheeler County showed the largest proportionate increase.

Production in north Texas, including those parts of Texas commonly referred to as north Texas, north central, and west central Texas, amounted to approximately 32,000,000 barrels in 1934, or about 6,000,000 barrels more than in 1933. As with the Panhandle, this increase probably resulted from increased allowables and intensified field activity, stimulated by better prices. Archer again was the most active county, with Young second. Although 290 out of 963 completions in Archer in 1934 were dry the ratio of dry holes to the total was less than in 1933, and the average initial was about 50 percent higher. The major part of the credit for this improvement in performance probably can be given to acidization.

Although production in the east Texas field declined from 204,954,000 barrels in 1933 to 181,143,000 barrels in 1934 the field easily retained its position as the premier field of the world and as the chief "threat" to market stability. Inasmuch as east Texas has been the haven of the "hot-oil" operators it is appropriate to review the estimates of illegal production in 1934. The average "hot-oil" production at the beginning of the year was about 30,000 barrels daily and by the end of February had reached 75,000 barrels daily; during March, April, and May it fluctuated around 50,000 barrels; in June it was reported as high as 100,000 barrels; in July and August it fluctuated around 75,000 barrels; it increased in September and October, so that by October 25, when the first Federal Tender Board entered the field it was generally estimated at 130,000 barrels daily. The activities of the Tender Board, the primary function of which consisted of granting tenders on interstate shipments of legal oil from the field, were instrumental in reducing the daily average "hot-oil" output almost immediately to around 35,000 barrels. In December the authority of the Railroad Commission of Texas was increased by passage of a law giving it power to issue transportation tenders on refined products as well as crude. The combined activities of the board and the commission reduced "hot-oil" production to an average of about 5,000 as the year closed. The total output of "hot oil" in 1934, based on the estimates outlined above, was approximately 22,500,000 barrels, all of which is included in the Bureau's total of 181,143,000 barrels for the State. The average bottom-hole pressure in the east Texas field, which is important as an index of the ability of the wells to flow, was about 1,275 pounds per square inch on January 1, declined to about 1,220 pounds in October, recovered a few pounds when "hot-oil" production was curtailed, and stood at around 1,225 as the year closed. The initial bottom-hole pressure was 1,625 pounds; the critical pressure—that is, the pressure at which the gas would come out of solution—is 740 pounds.

There were 3,441 oil wells completed in east Texas in 1934 compared with 2,407 in 1933. The total initial of the completions in 1934 was 6,483,000 barrels; the average was 1,880 barrels compared with 2,020 barrels in 1933. Before 1934 the east Texas field extended over parts of Gregg, Rusk, Smith, and Upshur Counties, but drilling in 1934 added Cherokee County to the producing column. The country surrounding the east Texas field was wildcatted actively in 1934, but with little success. A well several miles southwest of Rusk in Cherokee County looked promising for a time but did not keep its promise.

Production in the other pools of the east Texas district, that is, at Van, Cayuga, Boggy Creek, and a few small pools in Panola and Nacogdoches Counties, increased in 1934, chiefly because of a gain of about 2,600,000 barrels at Van. A new field—Cayuga, Anderson County—was added to the district in 1934. Although it did not come up to expectations it proved more of an oil field than its neighbor, Long Lake, and yielded about 600,000 barrels in the last 10 months of the year.

The central district, comprising chiefly the fields along the Balcones fault zone, was comparatively quiet in 1934; no important discoveries were made, and production continued to decline.

In spite of the fact that the number of oil wells completed in 1934 was nearly double that of 1933, production in west Texas declined from 55,344,000 barrels in 1933 to 50,344,000 barrels in 1934, or exactly 5,000,000 barrels. Most of the decline was in the Yates field, which produces about 30 percent of the total for the district. Church-Fields maintained its output, and Chalk-Roberts increased, but both the other two large fields, Hendricks and Big Lake, continued to decline.

Ward County again was the most active area in drilling, although the Yates field was credited with most of the new initial. About a dozen new productive spots were found, of which a pool 3 miles east of the Hendricks field had particular promise. Several deep Ordovician tests were drilled in 1934, including one to more than 10,000 feet. The results of these tests were negative, but that did not deter operators from going ahead with additional tests in the hope of finding horizons similar to that at Big Lake.

Production in the many comparatively small pools of southwest Texas totaled 10,106,000 barrels in 1934, an increase of about 2,700,000 barrels over 1933. Of the output in 1934 the Government Wells field produced about 2,450,000 barrels, or nearly 25 percent. Wildcatting continued active, and several new discoveries were made. Of these the Sam Fordyce field, Hidalgo County, attracted the most attention. About a score of wells were drilled at Sam Fordyce in the closing months of the year.

The Texas Gulf was one of the comparatively few important producing districts of the country which failed to increase field activity in 1934. The number of oil wells brought in declined from 1,030 in 1933 to 756 in 1934. The decline in drilling was attributable solely to the fact that most of the drilling at Conroe was done in 1932 and 1933.

Production at Conroe declined from 21,215,000 barrels in 1933 to 17,734,000 barrels in 1934, a reduction in the allowable being the principal cause.

Although a number of discoveries were made on the Texas Gulf coast in 1934 their quality appeared lower than for several years. Most of the discovery wells yielded distillate from sands at around 6,000 to 8,000 feet in depth; like most distillate wells, they were erratic performers. The usual crop of extensions, deeper sands, and overhangs were found following deep drilling along the edges of the older salt-dome fields. The much maligned Tomball field was extended and produced nearly 1,000,000 barrels in 1934.

Utah.—The output of crude oil in Utah continued negligible, as the new discoveries were confined to gas fields.

West Virginia.—In West Virginia, as in most eastern States, higher prices stimulated development, and production increased from 3,815,000 barrels in 1933 to 4,096,000 barrels in 1934. The number of oil wells brought in increased from 67 in 1933 in 171 to 1934. Drilling centered around the Pike pool, Ritchie County.

Wyoming.—Although the Salt Creek field, which produces about half of the crude in Wyoming, continued to decline, the other fields, including those yielding heavy black oil, were opened up enough so that the total output rose to 13,065,000 barrels from 11,227,000 barrels in 1933. Most of the increase came from the Frannie and Oregon Basin fields.

There were 44 oil wells completed in Wyoming in 1934 compared with 24 in 1933. Weston County, in which the Osage field is the only real producer, led in wells drilled; but Park County, or more specifically the Oregon Basin field, had most of the new initial. The principal new discoveries were Waugh, a black-oil field in Hot Springs County, and Quealy, a light-oil field in Albany County.

WORLD PRODUCTION

Unofficial estimates of world production of crude petroleum for 1934 indicate a total of about 1,490,000,000 barrels, which is 46,618,000 barrels (3 percent) above the final total for 1933 and slightly above the previous record established in 1929. As the United States produces approximately 61 percent of the total output in the world, it is natural that the trends of production in the United States and in the world should generally correspond; however, although the United States supplied the major portion of the increase in 1933 most of the gain in 1934 was made in Venezuela and in the U. S. S. R. (Russia).

The U. S. S. R. (Russia), where production remained virtually unchanged from 1932 to 1933, increased its output materially in 1934, with the result that a new record was established. This gain resulted primarily from government assistance rendered the industry as well as from increased internal demand. Venezuela, where production had remained on a level for several years, increased her output by about 20 percent in 1934. Iran, which ranked fourth in 1933, decreased slightly in output in 1934 and dropped to fifth place behind Rumania.

IMPORTS AND EXPORTS

Under the code, imports of crude petroleum and refined products were restricted to the average for the last 6 months of 1932. The code is not specific as to imports in bond and as to the separate limitations on crude oil and refined products, hence a direct comparison of the quota with the actual imports is difficult. However, according to testimony offered by A. H. Redfield of the Bureau of Mines, pursuant to an investigation of the oil industry by a subcommittee of the House Committee on Interstate and Foreign Commerce, imports of crude oil and refined products for direct domestic consumption for the last 6 months of 1932 averaged 98,000 barrels daily, while imports in bond, practically all fuel oil, averaged 10,000 barrels. In comparison, actual daily average duty-paid imports in 1934 were 98,000 barrels, and average imports in bond were 40,000 barrels.

Total imports of crude petroleum in 1934 were 35,558,000 barrels, compared with 31,893,000 barrels in 1933. Of the total in 1934, 4,863,000 barrels were imported into bonded warehouses and 30,695,000 barrels were duty-paid. About five-sevenths of the imports of crude oil in 1934 came from Venezuela; about seven-eighths entered on the Atlantic seaboard.

The expansion in exports of crude oil continued in 1934, when the total shipped out was 41,123,000 barrels, compared with 36,584,000 barrels in 1933. Canada, France, and Japan, the chief customers, increased their purchases of crude from the United States, their aggregate takings comprising 94 percent of total exports in 1934.

REFINED PRODUCTS

General review.—Gasoline is easily the most important refined product, both in quantity and value. The percentage yields, or the ratios of production to crude runs, are rough measures of the volumetric relationships of the various refined products. The yields for 1933 and 1934, as given below, indicate chiefly an increase in the production of the light fuel oils, such as range oil (kerosene) and domestic heating oils (distillate fuels) at the expense of the heavy fuel oils.

	1933	1934		1933	1934
Gasoline	43.7	43.5	Residual fuel oil	27.6	26.8
Kerosene	5.7	6.0	Lubricants	2.8	2.9
Gas oil and distillate fuels	9.2	10.6			

Data on the values of refined products as compiled by the Bureau of the Census for 1933 show a total of $1,360,521,559, with gasoline, naphtha, and benzine having a value of $773,181,965 (57 percent), fuel oils $253,236,655 (19 percent), and lubricating oils $142,444,081 (10 percent). Compared with 1931 these data indicate an increase in the ratio for gasoline but decreases in the ratios for fuel oils and lubricating oils.

Analysis of production and consumption of petroleum products in 1934

[Thousands of barrels of 42 gallons]

Product	Production	Imports	Exports	Changes in stocks	Domestic demand
Motor fuel:					
Gasoline	389,350	1	24,769	−7,403	406,416
Natural gasoline	32,935			+54	
Benzol	1,600		50		
Total motor fuel	423,885	1	24,819	−7,349	406,416
Kerosene	53,855		9,791	−159	44,223
Gas oil and fuel oil	334,777	13,442	28,540	−12,607	332,286
Lubricants	26,373		7,584	+301	18,488
Wax	1,674	132	711	+240	855
Coke	6,500		573	−1,611	7,538
Asphalt	14,717	87	1,325	+458	13,021
Road oil	7,684			−164	7,848
Still gas	44,391				44,391
Other finished oils	1,921	14	47	+15	1,873
Unfinished gasoline (net)	−3,633	64		−3,569	
Other unfinished oils (net)	2,003	1,626		+3,629	
Refinery losses	16,073				16,073
Natural gasoline losses	3,233				3,233
	933,453	15,366	73,390	−20,816	896,245

MOTOR FUEL [2]

Motor fuel, including natural gasoline and benzol as well as refinery gasoline, established a new record for domestic demand in 1934 of 406,416,000 barrels after having declined in 1932 and 1933 from the previous high of 403,418,000 barrels in 1931. Although the number of motor vehicles in use in 1934 was about the same as in 1933 the combined effect of the increasing trend in consumption per motor vehicle and improved business conditions in 1934 was such as to make

[2] By H. A. Breakey, Petroleum Economics Division, Bureau of Mines.

the 1934 demand 7.8 percent higher than the 1933 demand, or an increase from 377,003,000 barrels in 1933 to 406,416,000 barrels in 1934. The trends in supply and demand for motor fuel in recent years are shown in figure 65.

It is difficult to estimate accurately the number of motor vehicles in use during the past few years because of the leniency of many States in enforcing their automobile-registration laws. However, using the registrations as reported it may be calculated that there were approximately 22,532,000 and 22,225,000 motor vehicles in use at the beginning and end of 1934, respectively. Motor-fuel demand

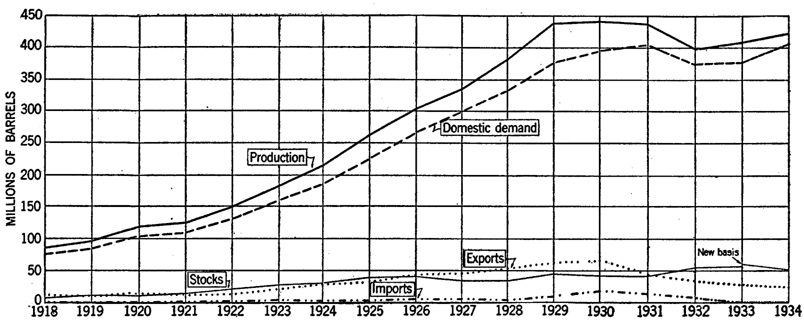

FIGURE 65.—Trends in production, domestic demand, exports, imports, and stocks of motor fuel, 1918–34.

per motor vehicle and motor vehicles in use, as calculated from registrations are shown in the following table:

Domestic demand per motor vehicle in use, 1924–34

Year	Domestic demand for motor fuel (barrels)	Motor vehicles in use July 1	Motor fuel demand per motor vehicle in use (barrels)	Year	Domestic demand for motor fuel (barrels)	Motor vehicles in use July 1	Motor fuel demand per motor vehicle in use (barrels)
1924	187,022,000	16,022,000	11.67	1930	394,800,000	24,710,000	15.98
1925	226,329,000	17,808,000	12.71	1931	403,418,000	24,263,000	16.63
1926	264,391,000	19,784,000	13.36	1932	373,900,000	23,208,000	16.11
1927	299,818,000	21,297,000	14.08	1933	377,003,000	22,650,000	16.64
1928	332,033,000	22,025,000	15.08	1934	406,416,000	22,968,000	17.69
1929	375,999,000	23,733,000	15.84				

Total motor-fuel production in 1934 was 423,885,000 barrels and comprised 206,917,000 barrels of straight-run gasoline, 182,433,000 barrels of cracked gasoline, 28,162,000 barrels of natural gasoline blended, 4,773,000 barrels of unblended natural gasoline, and 1,600,000 barrels of benzol. The ratio of cracked gasoline to the total declined from 44.3 percent in 1933 to 43.0 percent in 1934, the first such decline ever recorded in the Bureau's statistics. The proportion of straight-run gasoline increased from 48.0 percent in 1933 to 48.8 percent in 1934, while the proportion of natural gasoline increased from 7.4 to 7.8 percent. The proportion of benzol, although it has increased about 60 percent during the past 2 years, still accounts for only a little over one third of 1 percent of the total motor-fuel production.

The percentage yield of gasoline decreased from 43.7 percent in 1933 to 43.5 percent in 1934, marking the second year of decline from the high of 44.7 in 1932. This decrease in yield was accounted for in the lower yield of cracked gasoline, which was only 20.4 percent in 1934 compared with 21 percent in 1933. The Arkansas and Inland Louisiana district was the only one that continued an upward trend in percentage yield of gasoline in 1934. On the other hand, the percentage yield in California declined materially.

The decline in the yield of gasoline during 1933 and 1934 has disappointed some conservationists who cite individual yields up to 75 percent and who insist that we are consuming too much crude to produce enough fuel oil to maintain markets in competition with coal. Although statistics on fuel oil appear to support this contention increased operations at the low-yield plants in east Texas and a decline in activity at cracking plants due to cost considerations probably have had more influence in gasoline yields.

Production, demand, and stocks of motor fuel, 1933–34 [1]

[Thousands of barrels of 42 gallons]

Month	Production		Demand				Stocks end of month	
			Domestic		Exports			
	1933	1934	1933	1934	1933	1934	1933	1934
January	30,926	34,013	26,397	29,416	2,514	1,940	56,325	61,954
February	28,320	31,025	23,320	25,048	1,971	2,025	59,354	65,904
March	32,387	33,355	28,123	30,528	2,373	2,540	61,250	66,191
April	32,619	34,875	29,791	32,735	3,255	2,723	60,824	65,608
May	35,162	36,068	33,709	38,141	2,127	1,907	60,151	61,628
June	35,765	35,516	37,699	36,296	2,619	2,057	55,599	58,791
July	37,337	37,696	34,078	37,395	3,301	1,717	55,558	57,375
August	37,220	38,175	37,400	38,941	1,959	2,169	53,420	54,440
September	36,776	35,002	34,580	34,934	1,876	1,879	53,741	52,629
October	36,181	36,339	33,022	37,535	2,773	1,966	54,128	49,467
November	33,063	35,373	30,312	34,961	2,904	2,207	53,977	47,672
December	32,176	36,448	28,572	30,486	1,649	1,689	55,933 [2] 59,294	51,945
Total	407,932	423,885	377,003	406,416	29,321	24,819		

[1] Imports: 1933, 15,000 barrels; 1934, 1,000 barrels.
[2] For comparison with 1934.

As is shown in figure 67, refinery prices of gasoline were distinctly stronger in 1934 than in 1933, although it was felt generally throughout the industry that they were still too low to justify the basic price of $1 per barrel for crude oil. The peak price of 4.5 cents per gallon for U. S. motor gasoline (62 octane and below) at refineries in Oklahoma was reached in May, after which prices declined during the summer and fall. The low point of 2.75 cents was reached in October, after which a recovery raised the prices to 3.8 cents per gallon by the end of the year.

The average service-station price less taxes for 50 cities in the United States, which reached a high of 14.33 cents in January, declined to a record low of 11.72 cents in November, following severe price wars in several cities. Extreme prices were represented by Helena, Mont., where the price was 25 cents per gallon, including 6 cents tax, throughout the year, and Peoria, Ill., which reached a low of 9.5 cents per gallon, including 4 cents tax, for a few days in December.

Tank-wagon prices for gasoline followed the same general trend as service-station prices, although in this instance the changes were confined to a narrower range. The highest tank-wagon price of 13.34 cents (ex tax) occurred in January and the low price of 10.54 cents occurred in November, the same as with service-station prices. The differential between tank-wagon prices and service-station prices ranged from 0.99 cent in January to 1.64 cents in June.

State taxes on gasoline in 1934 ranged from a low of 2 cents per gallon to a high of 7 cents per gallon, in addition to a Federal tax of 1 cent per gallon plus various county and municipal taxes. The only States that changed their tax rates during 1934 were Arkansas, which increased its rate from 6 to 6½ cents on February 12, and Colorado, which increased its tax from 4 to 5 cents on February 1, but went back to 4 cents on September 1.

Motor-fuel stocks, including stocks of gasoline at refineries, at bulk terminals, and in pipe lines and stocks of natural gasoline, declined from 59,294,000 barrels on January 1 to 51,945,000 barrels on December 31. The increased demand in 1934 makes this decline seem even greater when these figures are expressed in terms of days' supply; for example, stocks on December 31 were equivalent to only 50.0 days' supply compared with 60.8 days' supply on hand at the beginning of the year. In view of the improvement in the stock position of motor fuel in 1934 it was generally expected that prices would improve accordingly. Actually, disastrous price wars pushed prices to new lows in several districts, the most common explanation being "distress gasoline from east Texas." The principal exception to the general decline in motor-fuel stocks was the Texas Gulf coast, where stocks increased 24.5 percent in 1934, or from 5,089,000 barrels on January 1 to 6,337,000 barrels on December 31. On the other hand, stocks in the Rocky Mountain district declined 51.0 percent, or from 1,532,000 barrels on January 1 to 750,000 barrels on December 31.

The relative rank of the States in gasoline consumption, as determined by the American Petroleum Institute from calculations based upon gasoline tax collections in the various States, is shown in figure 66. All States but the District of Columbia increased gasoline consumption in 1934. Total sales for all States were 16,595,180,000 gallons (395,123,000 barrels) in 1934 compared with 15,436,324,000 gallons (367,532,000 barrels) in 1933, an increase of 7.5 percent. States with only small increases were California, 0.8 percent; New York, 2.3 percent; and North Dakota, 3.2 percent. The largest increases were 24.0 percent for Wyoming, 22.4 percent for Montana, 18.2 percent for South Carolina, and 17.2 percent for Utah.

The duty imposed upon gasoline in June 1932 proved an effective barrier, and imports were negligible in 1934. Motor-fuel exports—24,819,000 barrels in 1934—declined for the fourth successive year from the 1930 peak of 65,575,000 barrels. There are several explanations of this decline. First, the enforced use of alcohol blends as motor fuel has tended to make some countries self-sufficient as far as motor fuel is concerned. Among the countries developing such policies are France, Germany, Great Britain, and Italy, which have been heavy importers from the United States. In addition, the excise taxes of June 1932 on imports has tended to divert an increasing quantity of South American oil from the United States to foreign countries. To these causes may be added the increase in crude-oil production and refinery capacity abroad.

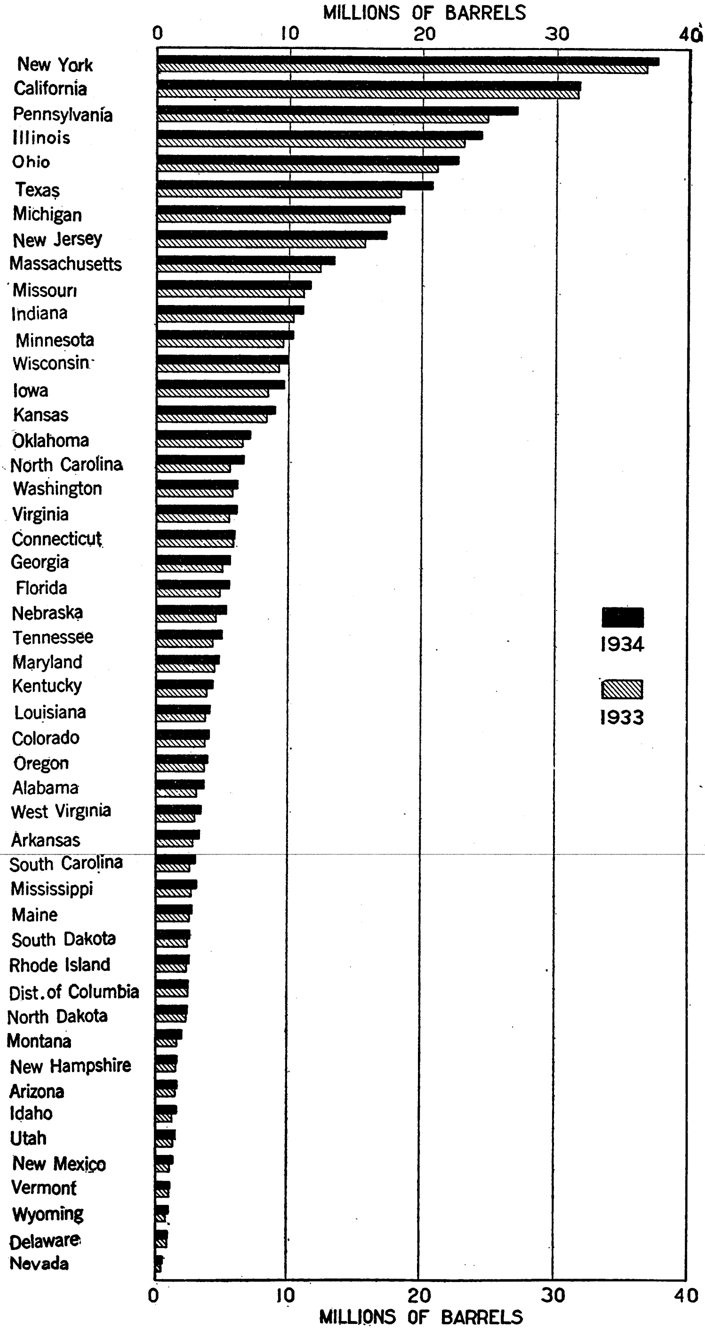

FIGURE 66. Gasoline consumption, 1933-34, by States.

The total mileage of gasoline pipe lines increased only 2 percent in 1934, but pipe-line deliveries of gasoline increased 18 percent, or from 38,196,000 barrels in 1933 to 45,383,000 barrels in 1934.

KEROSENE

The consumption of kerosene was stimulated in 1934 by increased use of tractors as part of agricultural recovery and by rapid growth in sales of range-oil burners, with the result that the indicated demand reached a new high mark of 44,223,000 barrels. This total represents a gain of 5,730,000 barrels over 1933, nearly half of which was represented by increased deliveries of range oil, a special grade of kerosene. Exports of kerosene, which had reached a low point in 1933, totaled 9,791,000 barrels in 1934, an increase of 9 percent over 1933. The increase in demand for kerosene was mainly supplied by stepping up the percentage yield from 5.7 percent in 1933 to 6.0 percent in 1934, although there was a small draft on stocks.

According to the American Petroleum Institute the quantity of kerosene inspected in 14 States in 1934 was 7,770,000 barrels or 2 percent above the total inspected in the same States in 1933. The increase in 1934 was noticeably less in the States affected most severely by the drought.

In general, prices of kerosene did not reflect the increased demand, the quotation for a standard grade declining from 9.7 cents per gallon on January 1 to 8.0 cents at the close of the year.

GAS OIL AND FUEL OIL [3]

The production of gas oil and residual fuel oil increased from 316,439,000 barrels in 1933 to 334,777,000 barrels in 1934. Gas oil and distillate fuels accounted for most of this gain, as the output of these lighter oils increased from 78,920,000 barrels (24.9 percent of the total) in 1933 to 94,972,000 barrels (28.4 percent of the total) in 1934. Increased demand and higher prices for distillates in 1934 tended to divert them into the market for fuels instead of their being used as cracking stock. The quantity of residual fuel oil produced in 1934 was 239,805,000 barrels compared with 237,519,000 barrels in 1933. The average percentage yield of gas oil and distillate fuels increased from 9.2 percent in 1933 to 10.6 percent in 1934, but the average for residual fuel oil declined from 27.6 percent in 1933 to 26.8 percent in 1934.

The estimated domestic requirements for fuel oil in 1934 were 332,286,000 barrels, a gain of 5 percent over the indicated demand of 316,344,000 barrels in 1933. The steadily expanding market for Diesel oils and the distillate grades of heating oils indicate that these lighter oils may be credited with the larger portion of the 16,000,000-barrel increase in 1934 over 1933. Consumption of fuel oil by class I railroads made a material gain in 1934, when 44,133,000 barrels were required compared with 40,370,000 barrels in 1933, while public-utility power plants increased their purchases of fuel oils by 4.4 percent in 1934, the total being 10,379,000 barrels compared with 9,940,000 barrels in 1933. In addition to the increased use of fuel oil by railroads and power plants the consumption for all other purposes showed an 11,000,000-barrel gain.

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[3] By A. T. Coumbe, Petroleum Economics Division, Bureau of Mines.

Imports of gas oil and fuel oil into continental United States totaled 13,442,000 barrels in 1934, or somewhat higher than in 1933, when 13,215,000 barrels were received from foreign sources. Imports of gas oil and fuel oil, including withdrawals from bonded warehouses for domestic use, declined to 4,730,000 barrels from 6,154,000 barrels in 1933, as the duty of 21 cents per barrel proved almost prohibitory. Imports into bonded warehouses of fuel oils which are duty free and intended primarily for ships' bunkers increased from 7,061,000 barrels in 1933 to 10,338,000 barrels in 1934; however, of the total in 1934, 1,626,000 barrels constituted fuel oil entered for refining at cracking plants as an unfinished oil, the products to be exported under bond. Exports of gas oil and fuel oil gained materially in 1934, totaling 28,540,000 barrels compared with 20,563,000 barrels in 1933. Shipments of fuel oils to the United Kingdom, Panama, Netherland West Indies, and Japan increased materially.

The trend of fuel-oil stocks continued downward in 1934, and net withdrawals of 12,607,000 barrels during the year brought the total to 110,397,000 barrels at the close of 1934. Gas-oil and distillate stocks increased about 5,600,000 barrels during 1934, while residual fuel-oil stocks declined about 18,200,000 barrels. Most of the fuel-oil stocks consist of residual fuel oil held in California. Heavy drafts were made on stocks in California for shipment to the East coast until about December 1, when the principal contracts expired. Because of the heavy coastwise shipments, which increased from 5,119,000 barrels in 1933 to 11,825,000 barrels in 1934, and curtailment in heavy crude production, stocks in California declined about 27,000,000 barrels in 1934.

There was an upward trend in prices for all grades of fuel oils in 1934. According to data compiled for the Fuel Oil Journal by Joseph E. Pogue the average price for all grades was $0.831 per barrel in 1934 compared with $0.667 in 1933. Increased demand for the heating grades of distillate fuel oils strengthened prices until midyear, when a downward tendency became noticeable. However, this trend was arrested, and prices were advancing again as the year closed. An average grade of bunker oil advanced from $1.20 to $1.30 per barrel in March 1934; this price was maintained until October 1, when mounting supplies along the Atlantic coast and lower prices at foreign ports forced the price down to $1.15 a barrel.

LUBRICANTS [4]

The production of lubricants in 1934 totaled 26,373,000 barrels or 11 percent more than the 23,775,000 barrels produced in 1933. The production in 1934 represents a yield of 2.9 percent of the crude oil run to stills compared with 2.8 percent in 1933 and 2.7 percent in 1932. Changing trends in the geographical distribution of lubricating-oil production that are of interest include the steadily increasing proportion of the total that is coming from the Appalachian and Oklahoma-Kansas-Missouri districts. The proportion for the Appalachian district has increased from 15.3 percent of the total in 1929 to 19.8 percent in 1934; and for the Oklahoma-Kansas-Missouri district from 7.8 percent in 1929 to 11.3 percent in 1934. The gains in these two districts have been chiefly at the expense of the Indiana-Illinois

[4] By H. A. Breakey, Petroleum Economics Division, Bureau of Mines.

district, where the output has declined from 11.4 percent of the total in 1929 to 9.0 percent in 1934, and the Rocky Mountain district, which has dropped from 1.7 percent in 1929 to 0.9 percent in 1934.

The domestic demand for lubricating oil ranged from a low of 1,302,000 barrels in February to a high of 1,677,000 barrels in October. In May, however, an abnormal indicated demand of 1,941,000 barrels probably was related to the storage of large quantities of refined products at terminals to avoid the tax of one-tenth cent per barrel on crude oil refined after June 9. The total domestic demand for lubricants in 1934 was 18,488,000 barrels compared with 17,152,000 barrels in 1933. Exports, which were equivalent to nearly half the domestic demand, totaled 7,584,000 barrels or about 8 percent less than exports in 1933.

Stocks of lubricants increased from 7,030,000 barrels on January 1 to 7,331,000 barrels on December 31. Most of the increase was in the Texas Gulf and Appalachian districts.

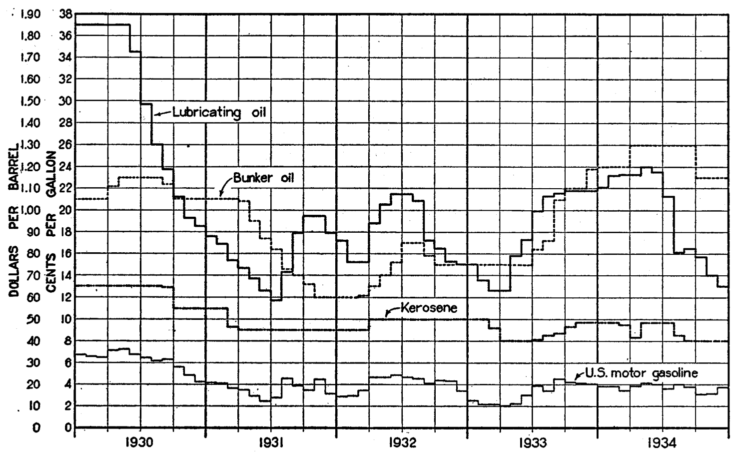

FIGURE 67.—Trends in prices of refined petroleum products, 1930–34, by months: Refinery price per gallon of U. S. motor gasoline, group 3; tank-wagon price per gallon of kerosene at Chicago; refinery price per barrel of grade C bunker oil at New York; refinery price per gallon of 150–160 viscosity at 210° bright stock in Oklahoma.

The trend in prices of lubricating oils in 1934 was downward in contrast to 1933, when sharp increases were made in late summer and early fall. As indicated in figure 67, the price of a representative grade of lubricating oil in Oklahoma in 1934 declined from 22 cents per gallon on January 1 to 13 cents at the end of the year.

WAX

The statistics of wax move in cycles of 1 to 2 years duration, during which either production or demand fluctuates enough to affect stocks appreciably. In 1934 production remained virtually unchanged, but demand declined materially, stocks accumulated, and prices weakened. In general, wax is the only refined product whose price moves in close conformity with the trends of demand and stocks. Compared with 1933 the total demand for wax in 1934 declined 27 percent, stocks virtually doubled, and prices were about 20 percent lower.

COKE

The production of petroleum coke has declined steadily in recent years, due principally to changes in operating technique at cracking plants—the cracking stock is circulated faster and there is less chance for deposition. However, the demand for coke as domestic fuel has increased, and consequently stocks have been reduced materially. Stocks of coke on hand at refineries on January 1 and December 31, 1934 were 727,400 and 405,100 short tons, respectively. The latter represents only about one fourth of the peak of 1,554,200 short tons reached on May 31, 1932.

ASPHALT AND ROAD OIL

The decline in the production of and demand for petroleum asphalt was checked in 1934 due, no doubt, to the increased use of Government funds in road construction. The demand for road oil also increased in 1934, probably for the same reason. Details of these two commodities may be found in the chapter on Asphalt and Related Bitumens.

STILL GAS

The production of still or refinery gas in 1934 totaled 169,374,000,000 cubic feet, a slight decline from 1933. This decrease was the first ever recorded in the output of this product, which is used chiefly as refinery fuel.

IMPORTS, EXPORTS, AND SHIPMENTS THROUGH PANAMA CANAL

Imports.—Total imports of refined products, including imports in bond, were 15,366,000 barrels in 1934, compared with 13,501,000 barrels in 1933. Virtually all of the imports were fuel oil either for use as fuel or as cracking stock (unfinished oil). Of the total imports 10,415,000 barrels entered in bond, and 4,951,000 barrels were imported for domestic consumption. Imports of wax, which rank next to imports of fuel oil in importance, totaled 37,348,000 pounds or slightly higher than in 1933.

Exports.—Exports of motor fuel continued to decline, but this loss in trade was more than offset by increased exports of gas oil and fuel oil, with the result that total exports of all refined products rose from 70,143,000 barrels in 1933 to 73,390,000 barrels in 1934. An increase in exports of kerosene in 1934 was about balanced by a decline in exports of lubricants.

Imports and exports of petroleum products, 1933–34

	1933	1934
Imports:		
Gasoline .... thousands of bbls..	15	1
Fuel oil .... do....	13,215	13,442
Lubricants .... do....	1	....
Wax .... thousands of lbs..	36,634	37,348
Asphalt .... thousands of short tons..	21.6	15.9
Unfinished gasoline .... thousands of bbls..	....	64
Other unfinished oils .... do....	....	1,626
Other petroleum distillates .... do....	19	14
Exports:[1]		
Motor fuel .... do....	29,321	24,819
Kerosene .... do....	8,959	9,791
Gas oil and fuel oil .... do....	20,563	28,540
Lubricants .... do....	8,218	7,584
Paraffin wax .... thousands of lbs..	247,769	199,104
Petroleum coke .... thousands of short tons..	190.4	114.2
Petroleum asphalt .... do....	215.8	241.2
Mineral spirits .... thousands of bbls..	58	47

[1] Includes shipments to Alaska, Hawaii, and Puerto Rico.

Exports of motor fuel in 1934 were 24,819,000 barrels, the lowest total since 1923. Most of the decline in exports of motor fuel in 1934 was attributable to France, which increased her purchases of crude to produce its requirements of gasoline The gain in exports of gas oil and fuel oil were fairly well distributed, with Japan, the leading customer, showing the largest increase.

Shipments through Panama Canal.—Shipments of gasoline from California "past the ports of Texas" to the Atlantic seaboard dropped from 11,305,000 barrels in 1933 to 8,694,000 barrels in 1934; however, shipments of the heavier grades of fuel oil more than doubled; hence the total movement rose from 21,020,000 barrels in 1933 to 24,719,000 barrels in 1934.

The coastwise movement of refined products from California through the Panama Canal (the westward movement is small and no crude has moved since 1929) has been a subject of controversy, particularly since the influence of these movements on allowable crude-oil production has become evident. Many in Texas cannot see any reason for transporting gasoline all the way from California, when Texas has an ample supply; on the other hand, some in California cannot see the logic of importing fuel oil, when it has a surplus. The one overlooks the influence of intercompany relationships and quality considerations; the other ignores the fact that most of the imported fuel oil is for ships' bunkers, a business that probably would be transferred to foreign countries if all imports were prohibited.

USES OF PETROLEUM FUELS

By A. J. Kraemer

SUMMARY OUTLINE

Current discussions of various aspects of the petroleum industry frequently mention the "demand" for crude oil as a controlling influence upon the relations of the problems of this industry to the social economy. In actual fact, however, there is almost no demand for crude petroleum as such. Except for a small portion of the total amount produced, crude petroleum cannot be used satisfactorily without partial refining and is not safe to use even as fuel. It is useless until it has been separated into its component fractions and these fractions refined into usable commodities. In recent years gasoline has been the principal commercial product of petroleum.

For many years there has been much interest in "the motor-fuel situation." Changes in characteristics of gasoline, new methods of manufacture, increased consumption, probability of scarcity, and possible substitutes for petroleum as a source of motor fuel have been subjects of absorbing interest to the petroleum and allied industries and to the public generally, and discussions of various aspects of these subjects have been published at intervals during the past 20 years.

During the period in which so much attention has been devoted to technologic, economic, and sociologic aspects of supply and demand relationships of gasoline the relative importance of other products of petroleum has changed gradually. One of the most noteworthy of these changes is the increase in the number of fuel-consuming units that obtain their fuel from the petroleum industry.

In addition to liquid fuels the petroleum industry markets a considerable quantity of gas fuel and coke and uses a large volume of refinery gas as fuel in its own operations. Although the competition from oil and gas has been recognized as one of the causes of the depressed condition of the coal industry, the large numbers of homes and business enterprises consuming petroleum fuels have not been given general recognition commensurate with their importance either as to number of consumers or aggregate consumption. If the demand continues to increase at the rate of the past few years petroleum fuels, particularly fuel oil, may soon be of interest to almost as many people as are now interested in the price of gasoline. Among these people must be included not only producers and users of petroleum fuels, but also producers and users of alternative fuels.

For the purposes of this discussion petroleum fuels are defined as comprising all crude petroleum unsuitable for use as gasoline. To promote accuracy and simplify the discussion Pennsylvania-grade crude oil and a few other crudes that contribute little or nothing to the fuel supply may be excluded. Those fractions of all other crude oils that are not suitable for use as gasoline may be considered to be either actually or potentially part of the total supply of fuel oil. To be sure, these portions of crude oil have other uses, notably as finished products in the form of illuminating oils, lubricants, paraffin wax, and asphalts, and as raw materials for manufacture of gasoline by cracking. However, any part of the available supply of crude oil that is not required to satisfy the demand for these commodities becomes fuel oil in one form or another.

Uses of petroleum fuels have expanded rapidly. It is doubtful that even those in daily contact with this development in one or another of its phases realize the extent to which petroleum has displaced other fuels, particularly solid fuels. This shift may not be regarded as irrevocably permanent, although in many instances a reversion to the older types of fuels would be made only against considerable resistance. For industrial and commercial uses generally fuel is purchased on a basis of total cost of delivered heat. Therefore, any displacement of other fuels by petroleum fuels in service of this class probably was made because users considered that use of petroleum would be more profitable.

Cracking.—The importance of the cracking process as a consumer of potential fuel oil as raw material must not be overlooked in any discussion of technologic factors that affect the supply and demand for fuel oil. In 1934, 182,433,000 barrels of gasoline were manufactured in the United States by cracking processes to augment the supply and improve the quality of gasoline obtainable directly from crude oil. Domestic demand in 1934 for gas oil and fuel oil (exclusive of cracking) was 332,286,000 barrels, and exports were 28,540,000 barrels, a total demand of 360,826,000 barrels for the year.

Thus it appears that by the cracking process a quantity of gasoline was manufactured in 1934 (almost entirely from potential fuel oil) equal in volume to slightly more than one-half the total "demand" for gas oil and fuel oil. Thus the cracking process is the largest user of fuel oil. This use of potential fuel oil is interesting to users of all types of fuel oil, as it points out one of the major demands and indicates the extent to which the price of gasoline governs the value (price) of fuel oil. In other words, fuel oil suitable for cracking cannot be cheap if the price of gasoline or crude oil is high.

The fact that fuel oil is suitable for cracking is of interest to producers of crude oil for much the same reason. The price of crude oil at the refinery cannot remain higher than the corresponding refinery cost of fuel oil satisfactory for cracking. This subject has been much discussed [1] in the light of past relationships of supply of crude oil

[1] Teagle, W. C., Fuel Oil and Its Influence on Conservation: Complete record of Public Hearings, Federal Oil Conservation Board, Washington, Feb. 10 and 11, 1926, pp. 19–24. Murphy, G. B., Economics of Skimming and Cracking: Oil and Gas Jour.: Vol. 30, no. 11, July 30, 1931, pp. 30, 137, 138. Kessler, J. B. Aug., Rationalization of the Oil Industry: Paper presented at World Petroleum Congress, London, 1933, and published in Proceedings; published also in Petrol. World (London), August 1933, p. 211. Oil and Gas Journal, Plan Proposed to Allocate Gasoline Production According to Value of Products Recovered: Vol. 33, no. 8, July 12, 1934, pp. 12, 13, 41.

and fuel oil, demand for gasoline and fuel oil, and cost of cracking fuel oil and crude oil.

Classes or types of petroleum fuels.—Petroleum fuels may be divided into the following seven classes: (1) Refinery gas, (2) liquefied petroleum gases, (3) gasoline, (4) kerosene and range oil, (5) domestic fuel oils, (6) industrial and commercial fuel oils, and (7) coke. Natural gas is excluded from the list, as it is not a refinery product. Gasoline is included only to the extent that it is used in pressure appliances, such as lamps, stoves, and blowtorches; as these uses are highly specialized and the small sales cannot be isolated from general gasoline sales it is impractical to treat this phase of consumption in the following discussion.

The extent of the consumption of the various types of petroleum fuels and the purposes for which they are used, the number of consumers (insofar as the information is available), and the advantages and limitations of the fuels for various uses are summarized in the following pages.

REFINERY GAS

The gas recovered in petroleum refineries from storage tanks, cracking and distilling equipment, and other places where vapors arise from bodies of liquid petroleum is called refinery gas or still gas. It has attained the position of a major product of petroleum refining in point of quantity produced. In 1934 the volume of refinery gas recovered in United States refineries, if reduced to the equivalent volume of oil on the basis of heating value, amounted to 44,391,000 barrels. This quantity was 82 percent of the volume of kerosene manufactured and 68 percent more than the volume of lubricants manufactured during the year. The increased use of cracking processes, the re-forming of straight-run gasoline to increase its antiknock rating, and the necessity for lowering the vapor pressure of gasoline have had an important part in increasing the production of refinery gas.

According to Hopkins,[2] petroleum refineries in the United States used 172,085 millions of cubic feet of refinery gas as fuel in 1933. Based on a factor of 1,400 B. t. u. per cubic foot the theoretical yield of heat from refinery gas in 1933 was 240,919 billion B. t. u. or 42.4 percent of the total heat used at refineries. This quantity of heat-producing material displaced an equivalent amount of other fuel. Refinery gas, a large part of which is produced incident to cracking, will continue to displace other fuels in petroleum refineries unless or until a more advantageous use is found for it. All available refinery gas will be used as fuel by petroleum refiners, irrespective of the price of other fuels, because the gas is at hand, it is a desirable fuel that produces high temperatures in furnaces, and no other uses have been found for it in the past in the quantities that were available.

Refiners recognize that burning refinery gas under stills is not justified if better and more advantageous uses can be found. To this end refinery technologists have investigated its possibilities, either as fuel in public-service corporation lines or as raw material for manufacturing motor fuels and chemical products. In describing results of experiments upon refinery gases, Wagner [3] says:

[2] Hopkins, G. R., Survey of Fuel Consumption at Refineries in 1933: Rept. Investigations 3270, Bureau of Mines, 1935, 6 pp.

[3] Wagner, C. R., Production of Gasoline by Polymerization of Olefins: Ind. and Eng. Chem., vol. 27, no. 8, August 1935, pp. 933–936.

A rough calculation based upon the yields obtained in these preliminary experiments indicates that refinery gases now available in the United States, if all were treated as in these tests, would produce about 1 billion gallons per year of aromatic hydrocarbons.

Another group of investigators [4] states:

Three hundred billion cubic feet of gas are produced yearly in the United States as a byproduct of the cracking process * * *. A new process which has recently been developed to the commercial stage can produce more than 1 billion gallons of gasoline of 82-octane number from this cracked gas.

Since these polymerization processes deal only with the olefin content of the gas which (according to Ipatieff and his coworkers) comprises about 50 billion of the 300 billion cubic feet of cracked gas and since (according to Wagner) fuel consumption for the process on a commercial scale should be less than 6 percent of the charge, the bulk of the refinery gas still would be available for use as fuel or for any better use that can be found for it in future.

LIQUEFIED PETROLEUM GASES

Liquefied petroleum gases include propane, butane, pentane, and propane-butane mixtures.

Propane and propane-butane mixtures are used mainly for supplying gas to consumers who are beyond the mains of companies supplying natural or manufactured gas. The gas under pressure and in a liquid state is distributed to consumers in metal cylinders, hence the name "bottled gas." The liquid, being released into the household system at atmospheric pressure, gasifies and is used in the same manner as ordinary gas supplied from gas-company mains.

"Bottled gas" is used in suburban residences not within reach of gas mains, in farmhouses, in camps and summer homes, and in a variety of other places where its convenience and freedom from dirt and odor outweigh its higher cost compared with other fuels. Data are lacking regarding the number of individual users of bottled gas, but available information indicates that the number is large and increasing.

Propane, butane, and mixtures of propane and butane either undiluted or mixed with air are delivered to consumers through mains in the same way as natural gas and manufactured gas. The American Gas Association [5] reports that in 1934 liquefied petroleum gas was being delivered through mains to approximately 30,000 customers in 171 communities in 28 States by 72 companies. These hydrocarbons are used also for enriching manufactured gas.

Industrial and miscellaneous users consume a large proportion of the marketed production of liquefied petroleum gases.

Statistics on marketed production of liquefied petroleum gases are given in Mineral Market Report 375.[6] Figures published by the Bureau indicate that marketed production of this class of petroleum fuels increased from 222,641 gallons in 1922 to 48,173,000 gallons in 1934. Of the latter quantity 17,681,000 gallons were used by domestic (household) consumers, 6,290,000 gallons were manufactured into gas, and 24,202,000 gallons were used for industrial and miscellaneous purposes.

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[4] Ipatieff, V. N., Corson, B. B., and Egloff, Gustav, Polymerization—A New Source of Gasoline: Ind. and Eng. Chem., vol. 27, no. 9, September 1935, pp. 1077-1081.

[5] Shea, G. B., Natural Gasoline: Minerals Yearbook, 1935, Bureau of Mines, p. 831.

[6] Coumbe, A. T., Jr., Increased Demand for Liquefied Petroleum Gases in 1934: Mineral Market Report 75, Bureau of Mines, 1935, 3 pp.

This brief discussion of marketed production of the class of petroleum fuels known as "liquefied petroleum gases" shows that use of these fuels has increased from a negligible quantity in 1922 to the point where they now are serving thousands of individual consumers who otherwise would be unable to use gaseous fuels.

KEROSENE AND RANGE OIL

Kerosene suitable for use as an illuminant in wick lamps and other wick-feed appliances is a product of careful selection of raw material and skillful refining. The basic qualifications for kerosene for this purpose are that it shall not be so volatile as to constitute a fire hazard and shall burn freely and steadily in a wick lamp, with as much freedom as possible from odor, smoking, incrustation of the wick, and clouding of the chimney. Despite their lowered costs and increased availability in recent years electricity and gas have not yet entirely displaced kerosene as an illuminant, and a real demand for kerosene as an illuminating oil seems assured for several years.

Distillate oil burners.—A significant development of the past few years is the increasing rate of conversion of coal- or wood-burning cooking and heating ranges in household kitchens to the use of oil as fuel. This type of oil-burning equipment has been adopted also in large numbers for original installation in ranges and for space and water heating.

These units formerly were called "range oil burners" from their use in kitchen ranges. Since range oil burners have been adopted for space and water heating they are now commonly called "distillate oil burners." This name has been adopted by the Bureau of the Census,[7] apparently to make a distinction in name between these burners and domestic oil burners, which also burn distillate fuel oil.

Speare and Cooley [8] describe this type of oil-burning equipment as follows:

Practically all range oil burners are constructed on the same basic principles, but differ in certain features of design which greatly affect their performance. In general, the complete unit as installed in the kitchen range consists of three parts.

1. The burner proper where the oil is vaporized, mixed with the necessary amount of air, and burned.
2. The regulating valves which control the volume of flame or the rate of combustion.
3. The oil reservoir which may differ in form according to the demands of the particular installation.

In its simplest form the burner itself consists of a base, usually of cast iron formed of two or more annular fuel-vaporizing grooves with alternate air channels. This base is surmounted by a series of concentric perforated cylinders or sleeves of which each pair forms a combustion chamber above its own vapor groove. The sleeves are made of a special bigh-chromium alloy steel, particularly adapted to resist the effect of continued heat. The temperatures encountered vary from 1,200° to 1,750° F. with a reducing atmosphere on one side of the steel and an oxidizing atmosphere on the other. A reinforced asbestos ring is usually placed in each groove for ease in lighting. One or more cover plates resting on the top of the nested cylinders baffle the flame and, by closing the air passage, force the air through the perforations into the gas chamber.

In this construction the usual relationship of combustible and supply of oxygen is reversed; an examination shows innumerable jets of air surrounded by an atmosphere of vaporized oil. This form of progressive combustion is noiseless, and gives a clean blue flame of intense heat with no smoke, soot, or odor.

[7] Bureau of the Census, Distillate Oil Burners; Monthly Statistics on New and Unfilled Orders, Shipments, and Stocks. Free on request to Bureau of the Census, Washington, D. C.

[8] Speare, L. F., and Cooley, C. B., The Range Oil Burner—Creator of a New Oil Market: Paper presented at 3d Midyear Meeting, Am. Petrol. Inst., Tulsa, Okla., May 19, 1933; published in Oil and Gas Jour., vol. 32, no. 1, May 25, 1933, pp. 54, 56, 62, 63.

One or more of these burners is rigidly supported in the firebox of the stove or heater. The supply pipe conveys the oil by gravity to the vaporizing grooves, the rate of flow being governed by the regulating valves. For the common kitchen-stove installation the fuel supply consists of a 2-gallon glass bottle inverted above a suitable reservoir which maintains a constant oil level at proper height. The principle is similar to the common water cooler, and has proved simple and reliable. With this arrangement the oil level in the base can rise only sufficiently to wet the lighting rings for quick starting, and under no condition can it overflow the vaporizing grooves.

In starting the burner the valves are opened, and the fuel in the asbestos rings is lighted with a convenient torch. The base temperature rapidly rises to the vaporizing temperature of the oil and, by the process of distillation, supplies each combustion chamber with a continuous flow of oil gas. In 5 to 10 minutes the burner will have reached a full flame, and the valves are adjusted for the desired amount of heat.

The major difference in burner designs lie in the construction of the base and the method used in vaporizing the oil and distributing the resulting gas. In one class the oil is fed to a central vaporizing cup; and, after the initial heating-up period, gas only is allowed to flow to the vapor grooves. In another design the vaporizer takes the form of a wide annular trough, where vaporizing of the fuel takes place. In a third class the oil is fed directly to the outer fuel groove, where it is vaporized and fed to the other grooves.

Distillate oil burners require a fuel similar to kerosene. The extent of this demand for fuel oil is indicated by the report of the Bureau of Mines that domestic demand for range oil in 1933 was 9,849,000 barrels.[9]

Schulz [10] gives the following data on production of this type of equipment.

Approximate annual production of distillate oil burners, 1930–34 [1]

Year	Range burners	Space heaters	Water heaters	Total
1930	76,096	39,413		115,509
1931	148,212	43,354		191,566
1932	224,394	44,430	5,175	273,999
1933	179,513	75,975	7,969	263,457
1934	71,446	88,283	13,874	173,603
	699,661	291,455	27,018	1,018,134

[1] Estimated by J. W. Schulz of the Fuel Oil Journal, New York.

On the basis of these figures it probably is safe to estimate that approximately 1,000,000 homes have distillate oil burners for one or more purposes. This use of oil as fuel reacts upon the demand for coal, gas, electricity, and wood for cooking and heating.

In reference to the moderately well-to-do home the sales argument is well made that oil-burning equipment eliminates the dirt and labor coincident with the use of coal or wood for cooking and heating with old-fashioned equipment. Although this has had an important influence in extending the domestic fuel-oil market the following quotation from Speare and Cooley [11] shows that the primary reason for a widespread increase in users of distillate oil burners may be traced to conditions in the homes of persons of small means as, for example, the factory workers of the New England States:

[9] Coumbe, A. T., Jr., Material Gain in Demand for Domestic Heating Oils in 1933: Mineral Market Report 324, Bureau of Mines, 1934.

[10] Schulz, J. W., Space-Heaters Outstrip Range-Burners: Fuel Oil Jour.: Vol. 13, no. 7, January 1935, pp. 63–65.

[11] Speare, L. F., and Cooley, C. B., work cited. (See footnote 8.)

The fact that thousands of factory workers are located in the New England States, many of whom operate their cook stoves for both cooking and heating, closing off all but the kitchen and 1 or 2 adjacent rooms during the winter, plus the fact that the price of oil compares very favorably with the price of coal in New England, has influenced up to the present time (May 1933) the location of the major market in this particular section of the country.

With this large group of users, the utmost economy is essential to existence, and a gallon of kerosene is frequently more convenient and cheap to get than a sack of coal or a bundle of wood. Furthermore, for many families the installation of a distillate burner in the kitchen range eliminates the need ot maintaining a separate kerosene stove for summer use.

The accompanying table shows that maximum production of distillate oil burners for cooking, space heating, and water heating was reached in 1932 and 1933, years in which the sales of luxury merchandise were at low ebb.

Aside from its use for illumination, cooking, and heating, kerosene is employed as fuel in tractors and stationary engines, as a solvent for asphalts used as a binder and surfacer for highways, as a vehicle for insecticides, for cleaning machinery, and for a variety of other purposes.

According to the Bureau of Mines [12] the demand for kerosene for consumption in the United States increased from 33,221,000 barrels in 1932 to 38,493,000 barrels in 1933 and 44,223,000 barrels in 1934, a record demand for kerosene in the United States. This increase of 11,002,000 barrels in domestic demand in 1934 compared with 1932 probably was due to increased use of kerosene as fuel rather than as an illuminant or for minor uses.

DOMESTIC FUEL OILS

The use of oil for heating homes has grown from an insignificant channel of consumption a few years ago into a market for fuel oil of real importance and is now one of the most wide-spread uses of oil fuel.

The Bureau of the Census [13] reports that shipments of oil burners within the United States in 1934 totaled 103,087 units. Of this number 83,654 were classified as domestic oil burners, 8,333 as boiler-burner units, 706 as furnace-burner units, and the remainder as industrial burners. Figure 68, from an article by Crane [14], shows how the number of domestic oil burners in use has increased from a few thousand in 1921 to more than 1 million at the end of 1934.

One million oil burners is a small number compared with the number of individual homes that may be warmed with automatic heating plants, and a large field for sales remains. It would not be surprising if in a relatively few years 5 million homes should be emancipated from the labor and inconvenience of old-fashioned heating methods. Whether these homes are heated with gas, liquid, or solid fuels remains to be seen and will depend in large measure upon the relative availability and cost of the three types of fuels and upon progress in developing trouble-free methods of utilizing the fuels in this way.

[12] Hopkins, G. R., Crude Petroleum and Petroleum Products: Minerals Yearbook, 1935, Bureau of Mines, p. 754.
Hopkins, G. R., Monthly Petroleum Statement P 128; Petroleum, Petroleum Products, and Natural Gasoline, December 1934, Including Preliminary Totals for 1934: Bureau of Mines, Feb. 5, 1935, 12 pp.

[13] Bureau of the Census, Oil Burners; Monthly Statistics on New and Unfilled Orders, Shipments, and Stocks. Free on request to Bureau of the Census, Washington, D. C.

[14] Crane, H. D., Production Totals 102,000: Fuel Oil Jour., vol. 13, no. 7, January 1935, pp. 9, 10, 50.

Assuming that 1 million domestic oil burners were in service during 1934 and that each consumed an average of 1,500 gallons of fuel oil during the year their total consumption of fuel was approximately 35,700,000 barrels.

Various types of domestic oil burners require fuels that range in volatility and viscosity from kerosene to heavy gas oil; a small number of burners can burn oil containing a small proportion of residue. Commercial standards for fuel oils [15] have been adopted by burner manufacturers and petroleum refiners, and troubles formerly experienced from variations in fuel-oil characteristics have been reduced greatly. In this connection, the following is quoted from page 6 of the Commercial Standard:

> Although composite experience in the use of Commercial Standard CS 12–33 indicates that the present revision will close the major loopholes for misunderstanding and unfair competition, it is apparent that additional data and possibly some new criteria are needed to insure a more complete adaptation of burners and fuel oils to each other.

Because of the convenience of fuel oil for domestic heating it appears altogether likely that the number of oil-burning househeating

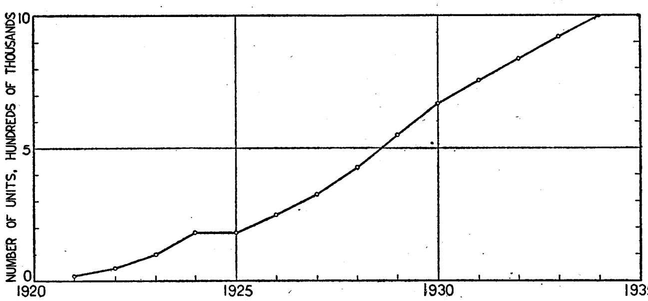

FIGURE 68.—Estimated number of domestic oil burners in use at the end of each year, 1921–34. The figures are estimated by H. D. Crane, of the Fuel Oil Journal, New York.

units in service will increase for the next 5 or 6 years at least. Even if the price of fuel oil should increase relative to the price of solid fuels the average householder who has a central heating plant probably would weigh carefully the factor of increased cost against convenient operation before giving up the relatively trouble-free operation of oil burning. Return of a more wide-spread feeling of economic security would do much to promote a substantial increase in the number of domestic oil burners in use.

INDUSTRIAL AND COMMERCIAL FUEL OILS

Among other uses, fuel oils are employed in industry and commerce for direct heating in heat-treating furnaces, for smelting and refining metals, and in ceramic furnaces; as fuel for Diesel-type internal-combustion engines; and for steam making, which consumes the major portion of all fuel oil used in the United States. The Bureau of the Census [16] reports that 10,394 industrial oil burners were shipped within the United States in 1934.

[15] National Bureau of Standards, Fuel Oils: Commercial Standard CS 12-35. For sale by Supt. of Documents, Government Printing Office, Washington, D. C., price 5 cents.
[16] Bureau of the Census, work cited. (See footnote 13.)

Direct heating.—Fuel oils have been used in industry for direct heating for many years. The demand for fuel oil for this purpose varies with industrial activity and the price of oil relative to all alternative fuels. However, for some industrial applications a fluid or gas fuel is almost indispensable and is in demand because of inherent advantages despite higher cost than other fuels. For certain purposes, such as heat treating, ceramic furnaces, and heating nonferrous alloys, fuel with low sulphur content is required. For some purposes, particularly for brass furnaces, salt must be absent from the fuel. For other industrial purposes oil is used because of its greater convenience and lower net cost than alternative methods of heating.

Statistics are not available to show the extent of the use of fuel oil in industry for direct heating; however, there is no doubt that the uses are numerous and varied, and the total consumption of oil for this purpose is large.

Fuel-injection engines.—Recent years have seen a great revival of interest in Diesel-type internal-combustion engines in the United States as well as in foreign countries. Since the Diesel engine was patented by Rudolph Diesel of Munich, Germany, in 1892 it has evolved into many variations for different types of service, including "semi-Diesel" engines and those in which the fuel is ignited by an electric spark plug instead of by spontaneous combustion due to the temperature of the compressed air in the cylinder of the engine. Throughout the range of sizes and types of this class of internal-combustion engines, with their various engine speeds and classes of service, the engines differ in their fuel-oil requirements for satisfactory performance. This problem has been discussed extensively in the technical press of the United States and in foreign countries in recent years and has been the subject of intensive investigation by petroleum refiners, engine manufacturers, and users.

The principal interest in oil-injection engines during the past year has been in the question of whether or not the high-speed engines in this class will become an important factor in transportation by private passenger automobiles, busses, trucks, railway locomotives, and aircraft. Apparently the most successful adaptation in the United States thus far has been in locomotives for branch-line passenger and freight service and for high-speed passenger trains on main lines. Some time must elapse before it will be decided definitely whether this departure from conventional railroad practice will grow in importance or will remain a comparatively small item in railway transportation. Probably its chief appeal up to the present has been its novelty and the sustained high speeds that are attained by streamlined passenger trains. In addition, Diesel-engined locomotives have appealed to railway executives because they appear to be a promising means of reducing costs of moving passengers and freight.

The following table is compiled from preliminary figures of the Census of Manufactures in 1933,[17] which are the most recent available

[17] Bureau of the Census, Engines, Turbines, Tractors, Water Wheels, and Windmills: Census of Manufactures, 1933. (Mimeographed release, Industry No. 1304.)

data on Diesel and other injection engines manufactured in the United States:

Number, rating, and value of oil-injection engines manufactured in 1933 [1]

Type of engine	Number	Rated horsepower capacity	Value
Compression-ignition (Diesel):			
Marine:			
For direct connection to propeller shaft	147	27, 515	$1, 225, 327
For electric drive and auxiliary use	61	13, 580	602, 437
Other:[2]			
Stationary	567	66, 505	[3] 2, 269, 011
Tractor, aircraft, railway, etc.[4]	61	15, 125	286, 708
Surface-ignition (semi-Diesel—hot-spot, hot-bulb, etc.) all types [5]	308	16, 603	319, 953
Injection engines, not reported in detail			458, 053
	1, 144	139, 328	5, 161, 489

[1] Compiled from reports of the Bureau of the Census.
[2] Not including Diesel engines made for installation in tractors or other machines built by same establishments.
[3] Includes engines valued at $41,374 not reported by number or by horsepower.
[4] Diesel engines made and installed by same establishments in tractors not reported separately.
[5] Separate data were collected for industrial portable and stationary engines and other types, but it was necessary to combine them to avoid disclosing approximations of the data for individual establishments.

Marine fuel.—Marine service is one of the applications for which fuel oil is particularly advantageous because of its mobility, permitting storage in oddly shaped spaces not otherwise useful aboard ship; greater heating value per ton and per cubic foot of storage space; cleanliness in handling and burning, resulting in absence of dust in loading the fuel aboard ship and absence of cinders and soot, leaving the decks cleaner and more comfortable for passengers; reduced labor requirement for handling and firing; and other reasons, in some instances including lower total cost. Fuel oil is used in vessels propelled directly by steam engines, in electric-screw vessels, and in vessels propelled directly by oil-injection engines. The following table, compiled from statistics published by the Department of Commerce,[18] shows the classification and tonnage of machinery-propelled vessels documented (registered, enrolled, and licensed) in the United States during the year ended June 30, 1934:

Documented machinery-propelled vessels of the United States, June 30, 1934 [1]

Type of vessel	Number	Gross tons	Type of vessel	Number	Gross tons
Oil fuel [2]	6, 201	8, 771, 343	Electric screw	104	296, 182
Coal burning	3, 387	3, 550, 657	Gas engine	12, 373	272, 470
				22, 065	12, 890, 652

[1] Compiled from reports of the Bureau of Navigation and Steamboat Inspection; figures include merchant vessels and yachts but not Government vessels.
[2] Includes both oil-burning steam vessels and oil-engine motor vessels.

More than half of the ships included in the table are in the class of motor vessels powered with gas engines, with an average rating of 22 gross tons. Omitting these small vessels, the figures show that vessels using oil as fuel, either for steam making or in oil engines, comprise

[18] Bureau of Navigation and Steamboat Inspection, Merchant Marine Statistics 1934, table 33, p. 66.

64 percent of the total number of all other machinery-propelled vessels and account for nearly 70 percent of the total gross tonnage of these larger ships. The statistics do not include vessels of the United States Navy, Army, Coast Guard, and other Federal agencies. Data on individual Government vessels are given in Merchant Vessels of the United States, 1934.[19]

Other steam plants.—In addition to the use of oil for steam making in marine service Interstate Commerce Commission reports show that in 1934 class I railroads used 44,133,000 barrels of fuel oil in locomotives (probably partly in Diesel-engined locomotives), and the United States Geological Survey reports that public utility power plants used 10,379,000 barrels of fuel oil in 1934.

COKE

Coke is produced in petroleum refineries as a byproduct of cracking and by destructive distillation of petroleum at atmospheric pressure. Significant improvement in the quality of cracking-still coke has been made in recent years, and a considerable demand for it has been created for domestic heating. When practice in burning it in residential heating equipment has been acquired it is a very satisfactory fuel, as it has high heat value, is smokeless, and usually contains less than 2 percent—often less than 1 percent—ash.

Until comparatively recently coke was used mainly as fuel in refineries. However, this use of coke has declined steadily since 1930, as the demand for coke for domestic heating has increased and as production has decreased. In 1933, 263,000 short tons of coke were used as fuel at refineries,[20] and approximately 1,725,000 tons were sold in the United States. Most of the petroleum coke sold in the United States, as well as that consumed at refineries, probably was used as fuel; thus, nearly 2 million tons of petroleum coke were added to the fuel supply of the United States in 1933 by the petroleum-refining industry.

In addition to the coke used in the United States 190,390 short tons were exported in 1933.

Hopkins [21] reports that 1,300,000 short tons of coke were produced in United States refineries in 1934 and that stocks were reduced by 322,300 short tons, a total indicated demand of 1,622,300 short tons during the year. Domestic demand in 1934 totaled 1,507,600 short tons, including coke used as fuel in refineries. The remaining 114,700 short tons were exported.

Although these data on production and uses of petroleum coke do not indicate that this byproduct of the cracking process is an important factor in the fuel supply of the United States, the figures add another item of considerable magnitude to the total quantity of petroleum fuels consumed annually in the United States.

SUMMARY OF INFORMATION ON USES OF PETROLEUM FUELS

Data available on the individual outlets for consumption of petroleum fuels leave much to be desired. However, sources of information

[19] Bureau of Navigation and Steamboat Inspection, Merchant Vessels of the United States, 1934. For sale by the Superintendent of Documents, Washington, D. C., price $3.

[20] Hopkins, G. R., Survey of Fuel Consumption at Refineries in 1933: Rept. of Investigations 3270, Bureau of Mines, 1935, 6 pp.

[21] Hopkins, G. R., Monthly Petroleum Statement P 128, work cited. (See footnote 12.)

mentioned in this paper form the basis for the following tentative conclusions regarding the uses of these fuels:

Refinery gas produced in 1934 (169,374,000,000 cubic feet) was consumed mainly in petroleum refineries as fuel and for that purpose replaced approximately 9 million short tons of coal or an equivalent quantity of other fuel.

More than 48 million gallons of liquefied petroleum gases were marketed in 1934 and used by an unknown number of individual consumers, including 171 communities in 28 States which were served by 72 companies.

The gas fuels derived from petroleum share with petroleum coke the two attributes that they are mainly byproducts of cracking and that no means has been found for converting them into other materials at competitive costs and in the large quantities that have been available. Liquid products of petroleum either find a ready market or can be interchanged more or less easily from one product into another. However, although the uses of gaseous fuels were largely or entirely in competition with other fuel, the fact should not be overlooked that if they had not been used in that way they would have been wasted. New uses are being found for them, and the prospect is that gradually larger and larger quantities of refinery gases will be converted into products that will remove the gases from competition in the fuel market. Low prices for gasoline and limited demand for other possible products have hindered this development up to the present.

Approximately 1 million distillate oil burners were in use at the end of 1934 for cooking, water heating, and space heating. An increase of 11,002,000 barrels in domestic demand for kerosene in 1934 compared with 1932 probably was due in large part to increased use of distillate oil burners.

Approximately 1 million domestic oil burners were in use at the end of 1934. Assuming an average consumption of 1,500 gallons of oil per burner, domestic oil burners consumed 35,700,000 barrels of fuel oil in 1934.

Fuel oil was used in 1934 to propel 6,201 United States merchant vessels with combined rating of 8,711,343 gross tons, which was 64 percent of the number and 70 percent of the gross tonnage of documented machinery-driven vessels, excluding vessels driven by gas engines. These data do not include vessels of the Army, Navy, Coast Guard, and other Federal agencies. Class I railroads in 1934 used 44,133,000 barrels of fuel oil in locomotives, and public utility power plants used 10,379,000 barrels of fuel oil in 1934.

Domestic demand for petroleum coke in 1934 was 1,507,600 short tons, including the quantity used as fuel at petroleum refineries. This quantity of coke was used mainly as fuel and replaced an equivalent quantity of other fuel.

The extent of the influence of the cracking process upon demand for fuel oil is indicated by the fact that 182,433,000 barrels of gasoline were manufactured by cracking in United States refineries in 1934. This quantity of gasoline was made largely from potential fuel oil. On the other hand, the cracking process was the major source of the 169,374 million cubic feet of refinery gas and the 1,507,600 tons of coke that comprised a large portion of the total supply of petroleum fuels in 1934.

INFLUENCES OF PETROLEUM TECHNOLOGY UPON COMPOSITE INTEREST IN OIL

By H. C. Fowler and R. A. Cattell

SUMMARY OUTLINE

Complex forces having interrelated technical, economic, political, and judicial significance are tending to change the thought of the whole social order in this country. This condition is strikingly evident as it pertains to the petroleum industry. Almost from the beginning of this industry various ideas and concepts have been in conflict regarding property rights to oil and gas, production without waste, extent of reserves, productive life of fields, maximum ultimate recovery, output in accord with demand, relations of price to availability of supply, and many other related subjects. Out of these divergent views has grown a certain unanimity of thought by virtually all elements or units of the social economy having a direct interest in oil, with the result that there is now a generally expressed desire to bring conditions to a state where sudden and disrupting change will not be imminent and to make possible the conduct of an orderly program of development and industry. Despite this common urge there has been a continuing, wide-spread difference of opinion as to how this desirable objective, generally referred to as "stabilization", can be brought about most effectively.

The following pages analyze what appear to be important effects of outstanding technologic developments upon existing thought regarding oil and their influence upon the public interest in oil. This analysis indicates that ordinarily the limitations or possibilities of any given program are measured in the long run by the feasibility of its technical procedure.

DIVERSIFIED GROUPS COMPRISING PUBLIC INTEREST IN OIL

The public interest in oil is a complex state or condition. Standing in the way of a full understanding of this subject is the frequently expressed and widely believed opinion that the consumer interest is the "public interest." This interpretation is restrictive, as the consumer interest represents only one of several diversified groups comprising the public interest, which actually is the composite of all integral parts of the social order, a few of which are discussed in the following paragraphs.[1]

First, there is that part of the public interest represented by the thought and actions of the business group of managing ownership. Because of the diversified components of industrial activity the part played by this group cannot be described in a brief summary statement. Like all other industries comprising subdivisions serving different purposes the objective of the petroleum industry as a whole, as represented by management, is to perpetuate itself through making available to consuming markets fuels, lubricants, and other manufactured products needed in the course of a civilized existence. The actuating force behind industry is expectancy of monetary gain in return for goods delivered and service rendered. The prominent position of the petroleum industry is indicated by the 12 billion dollars reported as its capital investment; to this may be added that of its companion, the natural-gas industry, which has a total invested capital reported as 2 billion dollars and upward. Further, the average annual value of petroleum, natural gas, and natural gasoline produced in the United States during the last decade has been well over 1 billion dollars, representing approximately one-third of the average annual value of all mineral products; this in turn is nearly one-half the value of agricultural products for the same period.

Closely allied with managing ownership on account of financial considerations is the group comprising investors looking for places to put their capital to work, with fair assurance of its security and a return commensurate with the risk. Investment in the petroleum industry has received frequent unfavorable comment because of the unhappy outcome of unscrupulous dealings and questionable ventures. However, this is not representative of some 2 million investors, many of them people with only moderate incomes who, in good faith, have invested their savings in oil-company stocks or other securities or in oil royalties.

Labor and management are on the same footing in that the primary interest of each group is the welfare of the petroleum industry, which depends upon the uninterrupted production of oil and the ultimate sale of products at a profit. Therefore the viewpoint of the worker in the oil fields, at the refinery, or at the service station is as essential in developing a composite picture of the public interest in oil as that of the company executive who represents business management, the consumer, or any of the other component groups.

According to reliable estimates 1,197,000 workers were employed directly by the petroleum industry in March 1934. Of this number, 114,300 were in the producing branch, 22,000 were in pipe-line operations, 113,800 at refineries, 147,900 in wholesale distribution, and 799,000 at service stations. The total did not include rig builders or the employees of drilling contractors. The present enrollment of petroleum-industry employees is reported to be approximately the

[1] The writers believe that some term such as "common interest" is more inclusive and conveys a better over-all picture than the term "public interest." However, the use of "common interest" does not seem to be well established in writings on this subject; and to obviate possible misinterpretation, as implying complete unity of thought and action to obtain an orderly and stabilized program, the term "public interest" is used generally in the following text as the combined, although at times divergent, thought of the social and industrial groups of the country.

same as when the given figures were compiled, with over 200,000 persons reabsorbed and put to work during the last 2 years. The annual pay roll is more than 1½ billion dollars. To this labor group should be added all those persons who receive employment indirectly because of petroleum activity, from prospecting for likely deposits throughout the whole course of oil's progress to its ultimate consumer. The number comprising the last subdivision can only be conjectured.

The attitude of the labor group toward management, as expressed by the workmen's satisfaction or dissatisfaction with prevailing wages, hours of employment, and provisions for health and safety, usually reflects the general economic conditions within an industry. Wages paid by the petroleum industry to its workers always have been at a high level compared with many industries, for a large percentage of the employees must be skilled in the various trades, have knowledge of special technique (as in the drilling of wells and the refining of oil), or be trained as salesmen in the marketing branch. Evidences of disputes between labor and management in the petroleum industry because of unsatisfactory wages or working conditions have been relatively few and mostly in local areas. Accident-prevention programs have been conducted actively for more than a decade with marked reduction in the frequency and severity of injuries to workmen.

The misapplied use of the term "consumer interest" has been mentioned. Primarily, the consumer's interest has been concerned with having assurance of a long-continued supply of the products he uses for his necessity, convenience, comfort, and enjoyment at a personal cost to himself as low as can be obtained. Every person is a potential consumer of petroleum products and of natural gas. From the standpoint of utility and ready availability from no other source the chief products are motor fuel and lubricants. However, sight should not be lost of the great quantities of fuel oil required for domestic and commercial consumption and for transportation on land and water, as well as the volume of crude oil marketed in the form of kerosene, paraffin wax, and the almost untold variety of products that go to fill human needs.

Many discussions of the problems of the oil industry fail to recognize sufficiently the landowner's place and influence, despite his somewhat peculiar position. As an outgrowth of our laws regarding property rights, a heritage from the English common law, the owner of the surface initially is also the owner of the mineral rights beneath his property. He may sell, lease, or convey these several rights in a wide variety of ways prescribed by definite legal procedure, but in effect the landowner is the "land lord" to those who produce oil and gas from his property. Some oil and gas producers own their land in fee because of special conditions or by reason of railroad land grants, as in California, but the outright purchase of holdings usually requires prohibitively large initial investments, and the leasing of acreage prevails in most of the oil and gas fields in the United States.

Frequently the landowner is an agriculturist trained to expect the recurrence of crops and the cyclic reproduction of livestock. For that reason, in his position of "land lord" he is likely to be overanxious to have harvested what he considers the "crop of oil" so that he may collect his share. Time and again operators have been forced to fulfill lease provisions immediately to the letter, causing them to drill new wells and produce excess oil in the face of uneconomic circumstances.[2] On the other hand, the prevailing leasing system has been an important factor in the unprecedented growth of the oil industry, and although the landowner group is relatively small in numbers, its influence upon the prevailing thought regarding oil is a strong one. Whether they as individuals and the country as a whole might have benefited more under some other system is not a point of discussion here.

Other industries supplying materials needed to produce, transport, refine, and market petroleum and its products—for example, steel, lumber, and cement—and the automotive industry, because oil is the source material for the fuel and lubricants of the motors it designs and builds, are groups to be included in a composite picture of what comprises the public interest in oil. Finally, there is the questión of oil for national defense, and the complex position of the Federal Government and that of the States and their subdivisions, involving legislation, regulation, and a multiplicity of other factors including taxation.[3]

Other groups might be named, such as competing-fuel groups, but those that have been mentioned will suffice to show why the widespread interest in oil is forcing a national oil policy upon the attention of this country. For many years attempts have been made to define the oil policy of the United States, but compared with the British viewpoint or, more extremely, the operation of the oil industries of some other foreign countries, it can hardly be said that the United States has so far developed a well-articulated policy pertaining to oil.

Leith [4] has pointed out that the many political, economic, and social considerations included in a national oil policy must be surveyed not only from the local and national viewpoints but from the world position as well. In a representative government such as that of the United States a national policy pertaining to a natural resource must be predicated upon the several interests involved, which collectively have been mentioned in the preceding paragraphs as the public or common interest.

PUBLIC ATTITUDE TOWARD PETROLEUM INDUSTRY BEFORE PRESENT ERA

Turning from discussion of some of the major groups that comprise the public interest in oil and now are thinking along widely different lines yet desire stability within the petroleum industry, attention should be given to the general public attitude toward the petroleum industry during the several outstanding periods of its history in the United States. Although there is no definite dividing line between the several eras a brief review of important sequences of events helps to show the stabilizing influence of technical developments upon present conditions. No attempt has been made to follow an entirely chronological continuity or to treat other than major events, although the writers are aware of the influence of many circumstances not cited in this paper.

[2] This thought was suggested by and given more detailed treatment in a Memorandum Regarding the Natural-Gas Industry, a joint report by G. R. Hopkins, H. S. Kennedy, and H. C. Fowler, prepared by the Bureau of Mines at the request of the Chairman, Committee on Interstate and Foreign Commerce, House of Representatives, Dec. 20, 1934. Published in House Report 827, pt. 4, 73d Cong., 2d sess., pp. III-XXXIV.

[3] Although the important influence of taxation upon the public interest in oil is recognized, that subject is outside the scope of this writing.

[4] Leith, C. K., What Is the Policy of the Mineral Industry?: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol., 1932, pp. 13-17.

Rapid growth of industry to supply demand for illuminants.—From 1859 to about 1870 and particularly following the Civil War the influence of oil had become felt throughout the country to a pronounced degree. During that period there were rapidly fluctuating increases in production throughout the Appalachian region which not infrequently demoralized the price structure of the oil markets. By the end of the period several hundred refineries were supplying kerosene to a growing population that had become conscious of a better means of illumination than had ever been known before. It had been fairly well established that the source of supply was not temporary and that part of the public interest represented by the consumers of kerosene was highly personal. Equally personal was the attitude of those engaged in finding new fields and in supplying the rapidly increasing consumer demand. The urge was to get the oil to calling markets as quickly as possible. Government interest was predominantly local; certainly it was not nationalistic. During that period, although some basic engineering principles were recognized and put to work—for example, the gas lift [5]—in the main petroleum was produced and refined through methods based upon trial and error. Outstanding as a predominating feature was a set of pioneer conditions that made unnecessary a knowledge of production control, as the accepted meaning of the word is employed today.

Centralized management of refining and transportation facilities.—The individualistic and highly competitive practices in the production of oil of the first period merged gradually into those of the succeeding one, 1870 to 1911. In fact, the frequently cited Pennsylvania court decision, which likened the fugacious and migratory nature of oil and gas to that of birds and wild animals and has influenced the whole course of the petroleum industry, was not rendered until 1875. Because the courts lacked knowledge of the working of physical laws within natural reservoir systems, that and subsequent legal decisions of the earlier part of the second period shaped the jurisprudence concerning oil and gas property laws so definitely that the so-called "law of capture", or the legal property requirement to reduce these minerals to possession, confronts and confuses the present social order despite the inaccurate postulates upon which it is founded.[6]

Logan [7] and others have pointed out that the economic life of the petroleum industry during this second major period is recorded in the history of the Standard Oil Co. By 1906 that organization, with its affiliates, controlled 86.6 percent of the total output of refined products.[8] However, the production of crude oil continued on an individualistic and highly competitive basis, with capital from diversified sources forthcoming readily to cover the highly speculative risks of unscientific exploration and drilling. That condition did not result in an excessive output of crude oil, except for one or two occurrences during the earlier part of the period. The Federal Trade Commission [9] has pointed out that because of the Standard Oil Co.'s ownership of

[5] Miller, H. C., Gas-Lift Method of Flowing Oil Wells (California Practice): Bull. 323, Bureau of Mines, 1930, p. 2.
[6] Fowler, H. C., Technical Developments in Petroleum and Natural Gas Production: Minerals Yearbook 1932–33, Bureau of Mines, 1933, p. 498.
[7] Logan, Leonard M., Jr., Stabilization of the Petroleum Industry: University Press, Norman, Okla., 1930, p. 13.
[8] Commissioner of Corporations, Report on the Petroleum Industry: Washington, D. C., 2 vols., 1907, pt. 1, pp. 13–18.
[9] Federal Trade Commission, Petroleum Industry—Prices, Profits, and Competition, report in response to S. Res. 31, 69th Cong.: S. Doc. 61 ,70th Cong., 1st sess., 1928, p. 64.

virtually all important pipe lines this small corporate group "had nearly as complete control of the output of crude as it would have had through ownership of the producing areas."

That evolutionary period of the country's industrial expansion stands out as one characterized by a complete lack of thought regarding a national oil policy. Instead, it was one of centralized private control by a small group of men with keen ability that served well the vigorous requirements of the time.[10] The effective price control of crude-oil production as exercised by the Standard Oil Co. during that era went a long way toward checking the tendency of individual operators to drill wells and produce oil far in excess of the available consuming markets. The concern of the Federal Government in the expanding control of the Standard Oil Co. was prompted by the expressions of alarm from the agricultural West over the rising industrialism of the East. The marketing of oil was outstanding, and the antitrust laws were invoked to check the expansion. The orderly production of petroleum was not an issue, for that condition was well-controlled.

Competitive expansion to meet increasing gasoline requirements.—Changed conditions emerged out of the gradual separation of the Standard Oil Co. into 33 separate companies, following the final dissolution by order of the United States Supreme Court in 1911. The character of the change was due partly to the separation; but concurrently new fields were discovered, new capital was brought together to form companies that not only produced oil but also transported, refined, and marketed their products, and the automobile was beginning to create a market for gasoline, making that product, rather than kerosene, first in importance.

After 1911 expansion was rapid and frequently wasteful. Competition between realined integrated companies as well as nonintegrated companies became more evident, and there were general periods of flush production caused by the discovery of prolific fields, interspersed with periods of shortage and attendant high prices. The principle of laissez faire was uppermost. On the technical side there was a general failure to recognize the significant part of natural gas in bringing oil from the reservoir to the surface. Many oil producers looked upon natural gas accompanying their oil as a necessary evil, and more than one field was prevented from producing its extractable quota because, through lack of correct engineering knowledge or the tendency of current practice to "follow-the-leader", vast quantities of gas were blown to the air in an effort to get the oil to "come in."

This practice of wasting the value of natural gas, both as an energy factor in the reservoir system and as a fuel after it had reached the surface, did not go on without efforts to call the attention of the industry to the fallacy of such unscientific operating methods. Engineering thought was being crystallized within the Bureau of Mines, whose engineers were beginning their studies (1910–14) of the nature of oil and gas in underground structures and were performing initial work in formulating a philosophy of technical study with the view of showing that if man would develop oil and gas resources to his greatest benefit he must harmonize his actions with definite natural laws,

[10] Montague, Gilbert Holland, The Rise and Progress of the Standard Oil Co.: Harper Bros., New York, 1903.
Tarbell, Ida M., The History of the Standard Oil Co.: McClure, Phillips & Co., New York, 2 vols., 1904.
Bureau of Corporations, Report of the Commissioner of Corporations on the Petroleum Industry: Washington, 2 vols., 1907.

because opposition brings its penalties of increased cost and diminished return.[11]

World-War period.—With the eyes of the world turned upon the conflict in Europe and particularly with the entrance of the United States into the World War in 1917 oil became a matter of deep concern; and every effort was bent by the industry, working closely with the Government through the United States Fuel Administration, to produce a maximum quantity of oil in a limited time. The results of applying technical knowledge that had been evolving gradually began to show in increased production and in the efficient manufacture of desired fuel products. The driving public became aware of the wartime need for petroleum through the "gasolineless" Sundays instituted and in general was willing to cooperate in conserving fuel. Never before had the attention of the whole country been brought as directly to the question of oil as an essential commodity, but this was an artificial condition, stimulated by temporary lack of supply and consequent high price, that would not have existed in times of peace.

Indications of impending shortage of oil reserves.—After the war period the mineral industries of the country were confronted with many difficulties attending the readjustments to lower levels of output, following the strain of meeting demands never before placed upon them. One very important fact that the demands of war forced upon the attention of the petroleum industry was the definitely limited supplies of its crude material. The suggestion of an oil shortage had been made repeatedly by various writers, but hitherto no large part of the industry had taken definite cognizance of the impending diminishing supply. For a year or two the scarcity of oil, with attending high prices, made it appear likely that overproduction never again would be an economic factor in the United States. Some companies even took steps to accumulate large stocks in storage above ground. The urge was to explore all favorable areas, resulting in extensive geological work and the increased drilling of "wildcat" wells. Some companies turned to fields abroad and their foreign explorations were looked upon with general favor. The total number of oil and gas wells drilled in the United States alone, which in 1920 reached an all-time peak of 33,911, is indicative of this search for more oil.

Competitive development of new fields leading to proration.—In rapid succession came discoveries of prolific horizons in southern California. The sites of these new fields were thickly populated and under diverse ownership. The town-lot drilling campaigns conducted in those fields are among the worst examples of highly competitive and frequently ruthless exploitation in accordance with the prevailing concept of the so-called "law of capture." These conditions led to overproduction. Shortly afterward new productive zones were discovered in the Mid-Continent area, and with the rapid development of the Seminole (Okla.) field, where large quantities of oil were brought to the surface by means of the gas lift, predominating thought turned to ways of restricting output through prorating the quantity of produced oil.

[11] Cattell, R. A., and Fowler, H. C., Fluid-Energy Relations in Production of Petroleum and Natural Gas: Minerals Yearbook, 1934, Bureau of Mines, 1934, p. 707.

The historical sequence of events pertaining to proration is far too long and complicated to be rehearsed in this paper.[12] It should be noted, however, that proration of oil production is not new. An effort was made to meet overproduction in Pennsylvania as early as 1869 and again in 1873 when a glutted market threatened the existing price level. There were other attempts from time to time in various parts of the country to control the production of petroleum, as in the Hewitt (Okla.) field in 1921. For this paper it suffices to state that the period of production control extending to the present followed appointment by the operators of a field umpire in November 1926 to cope with the situation developing out of the excessive production in the Seminole (Okla.) area.[13] With a present ability to produce more oil than markets can absorb the principal features of this latest era of the petroleum industry are expressed in the many efforts that have been made to hold oil in the natural reservoirs for use as needed, instead of permitting uncontrolled flow to the surface, with its disturbing effect upon the markets and prices.

SPECIFIC EXAMPLES OF GROWING PUBLIC INTEREST

The brief decade comprising the present era of production control, with its problems of attempting to keep supply within the bounds of market demand, did not in itself change prevailing ideas with reference to oil, for the newer concepts, opposed to unrestrained competition, actually have been a development of a growing public concern in oil extending over the previous 50 or more years. Specific action of various groups and of government, during the several transitory periods that have been discussed in the broader view, have affected the future of the oil industry. The following examples are illustrative.

Oil on public lands.—The Placer Act of 1870,[14] modified from time to time into various forms, had been the basis for acquiring oil and gas lands on the public domain. During the administration of President Taft a bill was passed [15] providing for the withdrawal from public entry of large tracts of possible oil and gas bearing lands. Later (in 1912 and 1915) two areas in California and one in Wyoming were specifically designated as naval oil reserves. By January 1916 more than 5½ million acres, mostly in the Western States, had been withdrawn from public entry, although many of these tracts were subject to restoration to the former holders. The disputes and litigation which grew out of the public-land withdrawals and the difficulties attending supervision of oil and gas operations on these lands under the then existing laws were an ever-increasing source of difficulty for the General Land Office. After long and protracted debate the Mineral Leasing Act of February 25, 1920, became law, and the supervision of operations under oil and gas leases on public lands became part of the duties of the Bureau of Mines until July 1, 1925, when the Bureau was transferred to the Department of Com-

[12] See Miller, H. C., and Lindsly, Ben E., Report on Petroleum Development and Production: Hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, on H. Res. 441, Petroleum Investigations, pt. 2, 1934, pp. 1273–1306.
[13] Brandenthaler, R. R., Morris, W. S., and Bopp, C. R., Engineering Study of the Seminole Area, Seminole and Pottawatomie Counties, Okla.: Rept. of Investigations 2997, Bureau of Mines, May 1930, pp. 132–133.
[14] 16 Stat. 217.
[15] 36 Stat. 847.

merce, and all of its regulatory activities were assigned to the Geological Survey.

It is unlikely that the Leasing Act had any great effect upon the discovery of new fields, but its economic influence in the public-land States has been evident.[16] Further, it established a definitely stated operating policy of the Government on these lands, as contained in the regulations governing the production of oil and gas. These regulations were prepared by the Bureau of Mines to prevent damage to the producing horizons and waste from them through specified methods which embodied the results of engineering studies of the Bureau and the best practices of the industry. Provision was made that has relieved many Government permittees from drilling all except wells currently necessary at times when operators holding private leases were being forced to drill many wells and produce the extractable oil from them in the face of overproduction and low prices.

Full discussion of the Government's interest in oil, as evidenced by its more than academic participation in activities on public and Indian lands, would require much space. The following instances indicate and exemplify this active Federal interest in oil lands: Development of oil and gas on the tribal lands of the Osage Nation, Oklahoma, and on other Indian lands; the Red River operations while the Texas-Oklahoma boundary was in dispute; the naval oil reserves; the initiation of a unit plan of operation on nearly 9,000 acres of public lands in the North dome of the Kettleman Hills field, Calif., under KENDA (Kettleman North Dome Association) management; and the acts of July 3, 1930, and March 4, 1931, amending sections of the Mineral Leasing Act of February 25, 1920, and providing that all Government permittees sign an agreement in reference to the future unitization of their holdings.[17]

Federal Oil Conservation Board.—The letter of President Coolidge authorizing the Federal Oil Conservation Board on December 19, 1924, marks the beginning of another phase of the crystallization of governmental interest in oil and the recognition of the influence exerted by engineering thought on petroleum subjects that had been coming steadily to the foreground. This definite pronouncement of the Chief Executive in which he (1) stressed the responsibilities of Government and appointed four members of his Cabinet to study the subject of oil conservation with the enlisted full cooperation of representatives of the oil industry, (2) directed attention to the Government's large interest in oil lands on the public domain, and (3) called upon technical advisers of the Board in the Government bureaus to contribute to the full discussion of ways and means of safeguarding the national security through the conservation of oil, probably did more than any other single act before that time to focus the attention of all concerned groups upon the subject of oil conservation as it affects the economic structure of the Nation.

The printed record of public hearings on February 10 and 11, 1926, and the five following reports [18] that were issued during the life of the Board reflect only part of the lasting influence of its activity upon the succeeding oil history of the country.

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16 Logan, Leonard M., Jr., work cited (see footnote 7), p. 66.

17 46 Stat. 1523.

18 Part I, September 1926; Report II, January 1928; Report III, February 25, 1929; Report IV, May 28, 1930; Report V, October 1932.

This Board was confronted with a difficult set of conditions, for its status was entirely advisory. It could recommend only along broad lines that the industry apply the knowledge made available through the studies of better ways of conserving oil and gas than those currently practiced. If any part of the industry chose to ignore the studied advice of the Board, it had no delegated authority with which to enforce its findings. There were bitter differences of opinion within the industry which added to the difficult task of accomplishing definite ends in conserving the oil supply of the country.

The Federal Oil Conservation Board was a psychological rather than an immediately effective force; it educated the industry and to some extent the public as to the principal problems of oil conservation requiring cohesive group action. For the first time in the history of the industry Government representatives, oil-company executives, engineers, economists, jurists, and others had the broad picture of oil laid before them. The net result was that people began to realize the great variety of elements comprising the public interest in oil and to recognize some of the complicated relations of one factor to another.

Despite the many limitations placed upon it, subsequent events have proved the efficacy of its constructive work, for time and again in the present efforts to obtain an economic balance between supply and demand and to correct current practices that stand in the way of wise use of the country's oil and gas resources, the premises have been based upon factual data and fundamental concepts developed from 1924 to 1932 in connection with the work of the Federal Oil Conservation Board.

Stabilization Forum.—Another organized activity (not governmental) that has helped to shape thought on oil is that of the Stabilization Committee of the Petroleum Division, American Institute of Mining and Metallurgical Engineers. Earl Oliver, chairman of the Petroleum Division in 1932, in outlining his plan [19] for the year's work, gave as his opinion that production control was the great problem ahead of the world for some time and said in part:

> We believe the prerequisite of any satisfactory solution of the oil industry's ills is an educational campaign establishing a better public understanding of the needs and merits of production control, by which we mean the maximum yield at the minimum cost coordinated to society's current needs.

As a part of that committee's efforts to arouse a common interest in stabilization, a series of 13 articles was published in the Oil and Gas Journal under the title, "A. I. M. E. Stabilization Forum," between May 1 and September 21, 1933. The four essentials for bringing about stabilization in the petroleum industry as developed in that forum were: (1) Balancing supply and demand, (2) greatest recovery at lowest cost, (3) standard of ownership rights, and (4) preserving ownership control. In reference thereto, part of a previously unpublished statement by H. C. Fowler on October 10, 1933 is quoted; this was a reply to a direct request for comment on the "Stabilization Forum" series:

> Even as such fields as Seminole, Oklahoma City, and East Texas in turn, have been proving grounds for engineering facts, it now appears that many of the economic, political, and legal concepts of the industry are being or will be subjected to the "acid test." Therefore it is likely that as the course of the petroleum industry is plotted under a Code of Fair Competition for the Petroleum

[19] Oliver, Earl, Plans for the Petroleum Division in 1932: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol., 1932, pp. 6–9.

Industry, pursuant to the National Recovery Act approved June 16, 1933, new or modified viewpoints will come to the foreground, and it is not unreasonable to believe that fast-moving developments will bring forth suggestions to augment the four essential needs of a stabilization program heretofore established by the forum.

Petroleum Code and reports of fact-finding committees after code adoption.—An attempt to evaluate the final effect of the Petroleum Code upon the public interest in oil would be premature, for the experiment is too much a part of current social life for the complete picture to be seen. Moreover, the recent decision of the Supreme Court declaring certain provisions of the National Industrial Recovery Act unconstitutional increases the uncertainty regarding the future course of oil under Government regulation. However, present-day conditions seem to bear witness to the truth of the quoted statement above made in 1933 that new developments growing out of the period of operation of the Petroleum Code will add further considerations to the four essential needs of a stabilization program as indicated by the forum. The crux of what now appears as a definite fifth item is the trend toward the formulation of a national oil policy. Earlier this paper stated that a United States oil policy must be predicated upon the thought of the several groups making up the public interest in oil. Assuredly, since adoption of the Code of Fair Competition for the Petroleum Industry, approved by the President August 19, 1933, there has been more public interest than ever before in the stabilization problems of the oil industry, not only by the industry and Government but also by the consumer, investor, and all other groups referred to in the first part of this paper. This interest in itself does not imply that a national oil policy will be formulated, but it gives a basis upon which to judge the existence of a definite trend in that direction.

The sequence of events from the initiation of the Petroleum Code to the appointment of a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, to make petroleum investigations in compliance with House Resolution 441, passed at the close of the Seventy-third Congress, second session (June 1934), cannot be recorded here. The comprehensive scope of the subjects into which the subcommittee was directed to inquire indicates in some measure how many new factors developed under the code to add to those of long standing which influence current thought pertaining to oil. It also points to the fact that the Government is actively considering the broad aspects of the petroleum problem.

This attempt to determine the essential facts of the industry and the public interest in oil between the adjournment of the Seventy-third Congress and the opening of the Seventy-fourth was a stupendous undertaking. The extent and thoroughness of the subcommittee's investigations are indicated by the four large volumes of testimony, special technical reports, and other pertaining material indexed in part 5 of the hearings; but even with this great quantity of current material before it, the subcommittee did not find it advisable to embody in its report a draft of any bill setting forth what its members believed should become legislation pertaining to the petroleum industry, and the subcommittee gave reasons for that position in its report.[20]

[20] Petroleum Investigation, report pursuant to H. Res. 441 (73d Cong.), Union Calendar 3, report 2, 74th Cong., 1st sess., Jan. 2, 1935, 12 pp.

It may be concluded that the subcommittee found a continuing divergence from a bond of common understanding as to what legislative action should be taken to bring about stabilization. In other words, the subcommittee found many of the same self-interested views expressed in the testimony that have predominated throughout the years of the industry. The weight of facts, however, called the subcommittee's particular attention to and impressed it with two conditions of first importance:

1. An excessive supply of petroleum and its products to meet current demand undoubtedly exists.
2. Based upon conservative estimates of known reserves, an excessive supply of petroleum to meet future demand does not exist.

After the subcommittee made its report to the House of Representatives another statement originated in a careful, independent survey of conditions with special reference to the effects of the Petroleum Code on small enterprises in the industry.[21] People in all parts of the country who are concerned with oil problems have given serious consideration to this report, of which the opening paragraph states:

This Committee has become convinced that no permanent benefits of material value to either small or large enterprises of the petroleum industry can be obtained under the Code without a permanent, assured, and effective balance of crude-oil supply and demand, nor can stability of the industry and conservation of the oil resources of the Nation be achieved without such balance.

The findings of both these investigating committees are not new in principle, but their restatement by official bodies representing large sectors of prevailing thought on petroleum matters call the attention of the country forcibly to the conditions or forces acting to change current thought in reference to oil matters.

National Resources Board.—The National Resources Board, an agency recently taking group action through the expression of its views, also has influenced the public thought in reference to oil matters. The President appointed the Planning Committee for Mineral Policy on April 7, 1934, and under the active direction of its vice chairman, C. K. Leith, this committee made a report [22] early in 1935 to the National Resources Board as "a preliminary statement of the major elements of policy, with recommendations for action on a few of them." In the letter of transmittal accompanying the preliminary report the Planning Committee for Mineral Policy stated its expectation of preparing a more complete report to be submitted to the President.

The main consideration of this group has been to see whether conditions with respect to all minerals call for "better coordination of national policy in the public interest."

Dealing with the subject of petroleum this committee pointed out that the limited reserves of oil and gas have been withdrawn to such an extent that prompt adoption of a national policy to insure a wiser and more efficient use of the remaining resources is imperative. The committee stated among other conclusions that such a policy should have the influence "that will enable the operators of petroleum prop-

[21] A memorandum for the press containing the Report of the Petroleum Code Survey Committee on Small Enterprises was released by the Department of the Interior on Mar. 28, 1935. The complete text of the Petroleum Code Survey Committee Report was printed in Nat. Petrol. News, Mar. 27, 1935, pp. 23, 24, 24 A-H, and 25.

[22] National Resources Board, Report of the Planning Committee for Mineral Policy, part IV: Washington, D. C., 1935, pp. 389-449.

erties (through technical and scientific knowledge) to use energy associated with the oil for moving it to the well and through the well to the surface, leaving a maximum of energy in the system available to do such work in the future, thus minimizing the quantity of oil to be left underground beyond recovery by ordinary means."[23] A complete reading of the Report of the Planning Committee on Mineral Policy and particular study of the section on petroleum suggest that the committee recognized the need for scientific analysis and the application of proved engineering methods if the public interest is to be served by a wise national oil policy.

TECHNICAL CONSIDERATIONS OF STABILIZATION

The public interest in oil at present is confronted with various concepts that have been evolved out of group and Government action during more or less definite periods in the history of the petroleum industry. The immediate task is to evaluate the limits and potentialities of technology in reference to the general objective of stabilization—the developing of deposits and production of oil and gas from them in an orderly sequence to meet current needs, using methods that will assure equitable distribution of production allotments and maintain the integrity of property rights. In doing this the other requisite of conservation must be met, as pointed out in the report of the Planning Committee on Mineral Policy.

Petroleum engineers have proved their ability to win more oil from the sands. At times they have been accused of doing their work too well, thus contributing to overproduction. Where only technical problems are presented by the physical conditions of the reservoir they have been able to devise means of bringing the oil to the surface in orderly sequence. The complexities of the social order make the problems of orderly development difficult and have called for a more encompassing role than engineering requirements alone demand of those engaged in technical pursuits. Today, petroleum engineering not only has a definite place in virtually every company's operations in its oil-field development, but the tenets of engineering principles are showing themselves ever more forcibly in economic considerations, in decisions of the courts, in statutes and regulatory orders, and in the general current thought pertaining to oil.

Many economic and legal considerations have become hopelessly involved over the problem of ownership of oil as it is produced from the underground strata. As an aid to better understanding of this subject, representative engineers and geologists throughout the country were asked in 1931 to state their views as to whether they believed it possible by engineering methods to determine with fair accuracy the relative contents of adjacent tracts in a common pool.[24] In other words, can each landowner be assured of receiving his share of the total recoverable reservoir content in proportion to the extractable fluid content within his holdings? The concensus of opinion at that time was that, given an opportunity to obtain the necessary engineering data, the computations could be made with assurance of equity to all. Several replies suggested the need for knowing more about the relation of factors, such as the solubility of the gas and the

[23] Work cited in footnote 22, pp. 407–408.
[24] Oliver, Earl, Stabilizing Influences for the Petroleum Industry: Trans. Am. Inst. Min. and Met. Eng., Petrol. Devel. and Technol., 1932, pp. 22–37.

permeability of the producing strata, to the quantity of oil recoverable from the individual tracts, and reference was made to "the capacity of wells to produce." Stephenson,[25] for example, pointed out the desirability of allocating production either on the basis of the energy utilized in producing the oil or upon a proper balance between the factors of acreage of the individual tracts and the producing capacities of the wells.

Much progress has been made since that time when engineers were feeling their way toward more scientific methods of allocating production in an effort to meet the justified objections to open-flow potentials; and today, as never before, they recognize the truth of the poignant statement:

> A knowledge of reservoir conditions is the starting point for attacking all problems of development, production, and the allocation of production.* * * If the engineering phases of the problem can be solved and tangible evidence obtained of reservoir conditions in all parts of the pool, then recourse to uneconomic practices would soon become a thing of the past.[26]

ALLOCATION OF PRODUCTION

The success or failure of any current program of production control depends upon the engineering methods used in allocating well quotas. These technologic requirements contrast with earlier restrictions on output which were the result of the business judgment of individuals and corporate groups as to how much oil should be taken from a field or area to supply a given market at a price satisfactory to them.

The problems arising from present curtailed production are many but in general fall into two major categories which are definitely related, yet are influenced by different factors. Under the petroleum code State quotas were specified and comparative allocations between fields were made later to give each field what was determined to be its fair share of the limited market demand of the State. The mechanism developed for handling that type of allocation has been described by Miller and Lindsly.[27] The engineering factors of a pool were requisite in determining the percentage of a State quota allowed to any pool during a given period, but the determined rate of withdrawal from the pool as a whole frequently has been the result of balancing factors of economic expediency against what the field could produce on account of its physical characteristics. There is reason to believe that some fields have been produced under prorated conditions at a rate lower than that dictated by the best engineering principles. However, in those fields where the pressure in the reservoir has been maintained and the energy conserved the main general effect of restricted production on a pool is retardation of the time of maturity in recovering the ultimate extractable oil. In the opinion of many engineers the ultimate recovery will be greater if the pool is produced under scientific control than if operated at capacity rate throughout its economic life.[28]

The allocation of production from the field quota to individual wells or properties, in an attempt to assure "ratable taking" to each

[25] Stephenson, E. J., Professor of Petroleum Engineering, Missouri School of Mines, Rolla, Mo. (see footnote 24).
[26] Sclater, K. C., The Course of Oil: Petrol. Eng., December 1933, p. 9.
[27] Miller, H. C., and Lindsly, Ben E., work cited, pp. 1296–1302.
[28] Moore, T. V., The Effect of Curtailment on Ultimate Recovery: Presented at 15th annual meeting, Am. Petrol. Inst., Nov. 12–15, 1934, Dallas, Tex., Drilling and Production Practice, 1934, Division of Production, Am. Petrol. Inst., 1935, pp. 35–40; also published in Oil Weekly, Nov. 19, 1934, pp. 27–32.

well in a common pool, differs substantially from the foregoing conditions pertaining to State and field allocations. There is immediate concern by the property owners and leaseholders, not only because the present worth of the oil is influenced by the rate of extraction but the actual quantity that may be taken from the wells of individual properties may be affected in large measure by the comparative rates of production on the several adjacent tracts. The following discussion is confined to those phases of the allocation problem pertaining to the "ratable taking" of oil from wells in the same field to which a quota has been assigned without attempting to expand upon or to explain the many factors in addition to those of engineering significance that have been considered in determining State and field "allowables."

The completely personal interest of an operator is centered primarily in (1) the quantity of oil and gas his well or wells are capable of producing under a set of conditions during a specified period of time and (2) the ratio between this quantity and the quantity he will be permitted to produce in accordance with the proration plan applying to his properties. This set of conditions led to the practice of taking well "potentials" in an effort to reach a basis for estimating the quantity of allowed production for individual wells throughout a given period.

Of all restrictive terms the word "potential" probably has been used more loosely and with more detrimental effect than any of the others. The mere statement that a well, tract, or field has a "potential" of a given number of barrels means little or nothing in relation to the capacity to produce—and the continuance of that established rate of production. "Potential" has been defined as "the rate at which a well will produce oil under any standard test conditions" and "open-flow potential" as "the rate at which a well will produce oil with atmospheric pressure at the well head" [29]; but the full implications of these definitions must be realized. Reservoir conditions change rapidly when and after wells are flowed to make capacity-production tests; the status of adjacent wells or tracts influences the the results of potential tests; and the mechanical conditions of wells appreciably affect the results. The potential method has been used extensively, but many erroneous figures have been established. In consequence, not only has production in a field been allocated inequitably, but field potentials have been raised to fictitious and impossible quantities; many oil royalties have been sold on this false basis, despite the fact that only meager knowledge of the fluid and energy relations in reservoirs is required to show the fallacy of buying oil properties on the basis of scheduled potentials.

Fortunately, the realization is growing that inflated potentials result in the uneconomic practices named as well as many others that cause unnecessarily rapid depletion of oil reserves and financial loss. Commendable progress has been made in working out scientific principles for allocating production—not on the basis of what a well can be made to flow in a specified number of hours with its adjacent wells closed, but rather by determining the comparative abilities of wells to produce efficiently with an optimum use of reservoir energy, through applying knowledge of reservoir and well performance.

[29] Topical Committee on Production Nomenclature, Report: Production Bull. 212, Am. Petrol. Inst., November 1933, p. 265.

The term "productivity index" is now being used extensively by engineers to indicate the measure of a well's capacity to produce. The Topical Committee on Allocation of Production of the Central Committee on Drilling and Production Practice, American Petroleum Institute, has defined productivity index as "the number of barrels of oil produced per pound differential in pressure between static and flowing bottom-hole pressure".[30] Although the committee states that there is much to be learned about this allocation factor the scientific thought upon which it is based indicates its applicability and practicability in many fields to supplant the "potential" method of allocation production with its evident objectionable features.

The use of an allocation formula which includes a productivity index or measure of the capacity of a well to produce oil and gas from the reservoir is a special application of the principles which have evolved from studies dealing with the control and operation of gas wells conducted by the Bureau of Mines in cooperation with the Natural-Gas Department of the American Gas Association. The efficacy and practicability of the so-called "back-pressure method" of gaging the capacities of gas wells to produce gas, supplanting the outmoded open-flow tests, have been proved [31], and it has been pointed out that the same fundamental relations in the reservoir and flow columns of gas wells, given in two Bureau of Mines reports published in 1929,[32] and in a more complete report on the subject in preparation,[33] are applicable to reservoirs containing oil and gas mixtures if suitable modifications are made to the basic equations pertaining to the flow of natural gas.[34]

The initial work of the American Petroleum Institute Topical Committee on Allocation of Production was cited by Cattell and Fowler [35] in outlining the application of fluid-energy relations of petroleum and natural gas needed to arrive at equitable allocations of production. That committee's revised progress report (November 1934) merits careful study by every person connected in any way with allocation problems, not only for its technical data but also for the value of relevant information. The committee has stated aptly in the aims of its study that all of this knowledge may "possibly lead to the ultimate adoption and application of such basic principles and factors as will promote the conservation of a valuable and irreplaceable natural resource, insure maximum economic recovery, and maintain equity between productive tracts in any pool."

Even after essential facts permitting the establishment of a proper productivity index for the wells in a given pool are determined there is still the vexing consideration of what the courts may hold as belonging to the individual interests in a pool, especially one that is not unitized. In this connection Bingham,[36] in his recent review of past,

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30 Topical Committee on Allocation of Production, Essential Engineering Factors in the Allocation of Production; Revised Progress Report: Drilling and Production Practice, 1934, Division of Production, American Petroleum Institute, 1934, p. 9 (reprint, p. 3).

31 Federal Oil Conservation Board, Conservation and the Diminishing Reserves of Oil and Gas: Rept. V, appendix VI, 1932, pp. 53–54.

32 Pierce, H. R., and Rawlins, E. L., The Study of a Fundamental Basis for Controlling and Gaging Natural-Gas Wells, pts. I and II: Repts. of Investigations 2929 and 2930, Bureau of Mines, 1929, 14 and 21 pp.

33 Rawlins, E. L., and Schellhardt, M. A., Back-Pressure Data on Natural-Gas Wells and Their Application to Production Practices: Monograph, 7, Bureau of Mines (in preparation).

34 Fowler, H. C., Petroleum and Natural-Gas Studies of the United States Bureau of Mines Inf. Circ. 6737, Bureau of Mines, 1933, p. 21.

35 Cattell, R. A., and Fowler, H. C., work cited, p. 714.

36 Bingham, I. F., Production Allocation: Oil Weekly, Mar. 25 and Apr. 1, 1935, pp. 19 and 27.

present, and future proration methods, points out that in addition to assuring equity and true conservation a satisfactory method of proration must be practicable and of a type that will be sanctioned by the courts. Any program of restricted production is almost sure to involve complicated legal considerations of property rights, but it cannot be claimed that these differences of viewpoint of landowners or leaseholders result from any change in the working out of fundamental physical laws of fluid and energy in reservoirs. Man's knowledge of them has increased, and fortunately the inadequacy of concepts that previously prevailed concerning oil and gas and their movement are being forced upon the attention of the courts. The legality of action is based upon the rulings of the courts, but a very important problem of stabilization during this period of production control is whether allocation formulas are to be shaped to conform with existing legal opinions or whether our laws, especially their interpretation, may be made to conform more nearly with known physical conditions in the reservoirs.

COMPARISONS OF CONTROLLED AND UNCONTROLLED PRODUCTION

Many criticisms have been levied at the whole scheme of proration. One of the reasons given is that inequities have been experienced under some types of allocation. Another cause for criticism is that under certain proration plans more wells have been drilled than necessary to obtain larger quotas for individual tracts. The assertion also has been made that no economic benefits can result from a production program that causes competitors to cooperate in what has been termed an "unnatural relationship." Comparisons of fields operated under highly competitive, "antidrainage" programs with those under reasonable production control always are open to additional criticism on the grounds that no two fields are identical, and proper weight may not have been given to some influencing condition in one that did not obtain in the other. However, if the existing facts of similarity and dissimilarity of fields are recognized, comparisons of results obtained from controlled and uncontrolled fields are helpful in analyzing the validity of the claims and in charting future courses.

The Yates pool in west Texas affords a concrete example of what has been accomplished in working out a program of orderly development in a major field during the proration period. For 8 years this field has been under restricted production based upon voluntary agreement of the operators. According to Mills,[37] who has reported the conditions of the field in some detail, after nearly 200,000,000 barrels of oil were flowed with a pressure drop of less than 0.85 pound per square inch for each million barrels of oil produced, there is an expectancy that the wells will continue flowing at least 10 years more (or until the pressure has declined to 350 pounds per square inch) and that 80 percent of the recoverable oil from the field will be obtained by natural flowing methods.

[37] Mills, Brad, Advantages of Conservation Program Demonstrated by Yates Performance: Oil Weekly, Mar. 25, 1935, p. 26.

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The Hendricks pool, also in the Permian Basin of west Texas, exemplifies many operating practices that Yates does not. Both fields were discovered about the same time and are of the same general type of structure, although Yates is larger in area. Competitive development in Hendricks resulted in rapid fingering of water into the producing formation. Reith[38] reported the field in a period of decadence at the end of 1933. Approximately 97 percent of the fluid produced at that time was water. By the end of 1934 the total cumulative oil production was approximately 179.5 million barrels. What Hendricks might have done is of course conjectural, but its high rate of extraction of 57.7 and 50 million barrels in 1928 and 1929, respectively, followed by a rapid decrease with an ever-increasing water production, has led engineers to believe that the competitive methods used in the earlier life of the field mitigated against the more efficient use of the energy in the reservoir system and that if there had been better conservation of the gas energy the early and rapid encroachment of water would have been delayed.[39]

Floyd and Raider[40] have made another valuable comparison between results obtained from a community lease in the Keokuk Falls pool, Seminole County, Okla., and from the Maud pool, Pottawatomie County, Okla. The Community 28 block comprising the Keokuk Falls pool is described as the first and only pool in Oklahoma (February 1935) where through voluntary restriction reservoir pressures are being maintained in balance with the rate of encroaching edge water. After showing that the two fields are comparable, Floyd and Raider state:

> Approximately 40 percent of the ultimate recovery from the Maud pool was produced by natural flow during 10 percent of the life of the pool, whereas at Community 28 it is expected that at least 75 percent of the ultimate recovery will be produced by natural flow, and if the water drive is effective, it is quite likely that it will be produced almost to depletion by natural flow. In the Maud pool 149 producing wells were completed as compared with a probable total of 25 or 30 in the Keokuk pool. Yet the recovery at Maud is estimated at approximately 74,000 bbl. per well as compared with an estimated recovery of 300,000 bbl. per well at Keokuk, Community 28.

They point out further that in the Maud pool operators and royalty owners whose properties were developed in the later life of the field were kept from their fair share of the wealth of oil, gas, and energy in the underground structure. Placed on a monetary basis, Floyd and Raider give the following figures: The total cost of developing the Maud pool was $11,973,000, with an average cost per barrel of oil of $1.09, whereas similar figures for the Keokuk pool were $2,150,000 total cost, and $0.29 per barrel.

Unit operation of oil and gas pools has been called the antithesis of competitive practices, and it is well recognized that prorating production among the wells of a pool operated under a unit plan usually is much simpler than in one where there is diversity of ownership and company-operating policies. However, the two subjects are closely related in their common objective of stabilization, because an allocation program based upon good engineering is an attempt to

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[38] Reith, Colin W., Development and Production in West Texas, 1933: Trans. Am. Inst. Min. and Met Eng., vol. 107, Petrol. Devel. and Technol. 1934, p. 344.

[39] Mills, Brad, Hendricks Remains Profitable Field Despite a Large Water Production: Oil Weekly, Apr. 8, 1935, p. 24.

[40] Floyd, F. W., and Raider, M. L., Substantial Results Are Derived from Unit Plan Used at Keokuk Falls: Oil and Gas Jour., Feb. 14, 1935, p. 10.

accomplish, between different landowners through setting up certain specifications, what the management of a unit-controlled pool would do in the interest of the most efficient operation of the joint holdings. Their differences in approach to the problem of stabilization—a subject brought squarely before the industry in the pronouncements of Henry L. Doherty in 1924 in which he crystallized a definite plan of unit operation—opens such a wide field of thought that it cannot be discussed in detail in this paper. Miller and Lindsly [41] have reviewed carefully current unitized production control versus competitive methods. Avery and Miller [42] have considered the subject from the geological viewpoint, and the legal aspects of unit operation have been treated recently by Hines.[43]

However, the facts presented in the two foregoing comparisons, to which many more could be added, seem ample proof that where controlled production has been based upon good engineering practices the operators have been more than compensated in financial return for any restraints placed upon them, and the public interest has been served better through increased production than in fields developed under highly competitive practices.

PRODUCTION CONTROL IN KETTLEMAN HILLS FIELD

In the North Dome of the Kettleman Hills (Calif.) field problems of allocating production to wells have presented many difficulties. The machinery devised for handling the Federal allocations to the several oil-producing States under the Petroleum Code and the method of allocation to wells in the North Dome, originating with the Kettleman Hills Advisory Board, have been described.[44] Following hearings of an appeal of the Superior Oil Co. and Amerada Petroleum Corporation, Calif. (not participants in the Kettleman North Dome Association) with reference to the allocation plan, the Oil Administrator issued an order on March 25, 1935, establishing a new procedure in allocating production in the Kettleman Hills North Dome field. This order, effective April 1, 1935, based upon the recommendations of the Petroleum Administrative Board and its Technical Advisory Committee, is significant as several new departures were presented that pertain to methods of allocating production and related matters.[45]

In analyzing the trend of the course of oil it is advantageous to look carefully at the major points of the conclusions of the Petroleum Administrative Board report, which were the substance of the Oil Administrator's order.

The Petroleum Administrative Board found the former allocation method neither unreasonable nor inequitable but considered it was not in the direction of recovering maximum ultimate production, stating further that the objective is to conserve oil and prevent waste by means of a method—based upon subsurface pressure data—giving a productivity index which will reflect the relative capacities of the wells

[41] Miller, H. C., and Lindsly, Ben E., work cited, pp. 1249–1273.
[42] Avery, C. Dwight, and Miller, Charles J., Relationship of Geology to Unit Operation of Oil and Gas Fields, Involving Government Land: Bull. Am. Assoc. Petrol. Geol., vol. 18, no. 11, November 1934, pp. 1445–1492.
[43] Hines, Leroy H., Some Aspects of Unit Operation of Oil and Gas Pools and Fields: U. S. Geol. Survey, 1934, 53 pp.
[44] Miller, H. C., and Lindsly, Ben E., work cited, pp. 1296–1302 and 1302–1304.
[45] A memorandum for the press containing the report and recommendations of the Petroleum Administrative Board and the Secretary's order was released by the Department of the Interior on March 28, 1935.

to produce oil. The point was made that well allotments should "provide for the establishment of more uniform pressure gradients throughout the field."

The Petroleum Administrative Board stated its opinion that "under conditions presently existing, the use of acreage as such is not now essential in the Kettleman Hills North Dome field to the proper intrafield allocation of the field quota", with the view that no operator would have an advantage because he might hold more acreage than his neighbor. However, the phrase, "acreage as such", in the foregoing statement should be noted, for actually an acreage factor was provided to regulate volumetric withdrawals. To this end the field was divided into unit areas "which shall be twice the average area of a well space as per the present established well-spacing program." Provision also was made for a change in the allocation formula if the present well-spacing density was changed. Further study shows that the method is not substantially different, except in some details, from the findings of the American Petroleum Institute Topical Committee as to ways of minimizing drainage across property lines and of discouraging unnecessary drilling by determining a unit area for each pool, to which the productivity index may be applied. However, the Petroleum Administrative Board report, in dealing with this phase of its allocation plan, emphasized the definite quantity of oil recoverable from the reservoir beneath a property. This is in contrast with some allocation programs where the acreage holdings play an important part and are permitted to participate in the recovery from the pool in proportion to those holdings, irrespective of the number of wells drilled on the unit areas. The emphasis of the Petroleum Administrative Board report in this regard is based on engineering fact, for it is well established that the same conditions seldom exist throughout the extent of a pool, regardless of the apparent uniformity of the underground structure.

The formula of the Petroleum Administrative Board for allocating production includes recognition of the following factors—which for purposes of exact determination are expressed in mathematical terms but are discussed here only in their general aspects:

A minimum allotment is specified to each well to assure recovery of actual lifting cost and referred to as "the wages of a well based upon and limited by its performance." The productivity of each zone is recognized, and provision is made to apply the allocation formula to each of the several producing zones separately. Volumetric withdrawal of oil and gas per tract in the "gas-cap" and "black-oil" areas is provided for on the present basis (as determined by the Kettleman Hills Advisory Board) of a conversion factor of 1,000 cubic feet of gas at atmospheric pressure equivalent in volume to 1 barrel of oil in terms of reservoir space, with provision made for determining a conversion factor on the basis of subsurface conditions prevailing in each tract.

First taking account of the specified minimum well allotments and special allotments because of exceptional water conditions, the remaining field allotment is made by use of the stipulated allocation formula to ascertain "the comparative ability of a well to withdraw oil from the producing formations without causing excessive pressure gradients or other conditions conducive to waste." The productivity index is virtually the same as that defined by the American Petroleum Institute Committee.

With the expressed intent of evaluating the ability of a producing zone to yield oil to the well, independent of the manner of its completion and the method of its production, transfer of allotment from one well to another was looked upon with disfavor in the Petroleum Administrative Board report because of the disturbing effect upon the adjustment and maintenance of reasonable pressure gradients. The transfer of allowable oil production from one well to another has been permitted under specified conditions in some fields—for example, the Oklahoma City pool—in an effort to conserve gas.[46] The two fields cannot be compared directly in this regard, but to prevent unwarranted pressure drops between wells it is fundamental to consider whether the gas volume and the oil volume in a pool are directly connected or whether each should be treated as existing in a separate structure.

Some other specifications were made in reference to putting into effect the newer allocation program for the Kettleman Hills North Dome Field and the making of adjustments from time to time as occasion demanded based upon subsurface data to be obtained. The Oil Administrator's order expressly directed the office of the Oil Umpire of the Central Committee of California Oil Producers, the appointed agency to make the allocations to and in the several fields in California under the Petroleum Code, "to examine promptly the other fields in California where conditions conducive to waste and unfair production practices may be similar to those encountered in the Kettleman Hills North Dome Field" and to take steps to allocate production in those fields in accordance with the principles outlined for Kettleman Hills.

This order of the Oil Administrator contained a definitely stated method of allocation for the largest field in California in which the Government has a special royalty interest. Under the Petroleum Code this order had the effect of law, and certain suggestions for coping with the complicated technical and legal problems of property rights as they pertain to the "fugacious minerals", oil and gas, were incorporated in it. The ultimate effect of the application of specifications of this type upon the production of both oil and gas can be determined only after the results of their operation can be recorded for study. Nevertheless, the import of the provisions included in the order seems of more than passing significance in considering the trend of the interest in oil and its associated hydrocarbon, natural gas.

The technical evidence of the report set up a mechanism for withdrawing oil and gas in an orderly and equitable manner from the reservoir by control of pressure gradients permitting each property owner to take from within his boundaries *in the reservoir* his proportionate share of oil and gas in accordance with the ability of his property (within the reservoir) to produce these fluid minerals through the wells on his tract.

[46] Federal Oil Conservation Board, Conservation and the Diminishing Reserves of Oil and Gas: Report V, appendix VI, 1932, pp. 50–51.

"RULE OF CAPTURE" AND OWNERSHIP IN PLACE

At first thought the objective of preventing drainage from one property to another through the maintenance of proper pressure gradients and the other devised means of the order may seem at variance with some of the statements in the body of the Petroleum Administrative Board report in reference to "the rule of capture", where it was stated in part:

> * * * we find the only general rule of law or legal principle by which we may be guided is that of reasonably preserving for each operator taking from a common underground source of supply the total amount of oil and gas which he would have been able to capture in the absence of curtailment.

The argument substantiating this conclusion is too detailed to be quoted here, but the theory was that the rule of capture is essentially a rule of ratable taking and that restricted production must be on that basis. Such a line of reasoning differs from general current thought in respect to the rule of capture. In support of this theory the legal concept was stated that vested property rights do not privilege a man to drain his neighbor's property. Instead, the Petroleum Administrative Board report stated:

> * * * The courts have presumed, *in the absence of any restrictions upon production*, that ratable taking from a common reservoir of oil and gas may be achieved by permitting each operator to protect himself from drainage by drilling and operating his wells as he sees fit. The ability of one to capture has been limited by the ability of all others to capture. It seems clear that the courts have sought to establish a self-operating principle which, in the absence of legislative control of production, would accord each operator his fair share of oil in a pool.

This suggestion that the rule of capture and the rule of ownership in place are neither necessarily discordant nor inconsistent with each other has been expressed by others. Wood,[47] speaking as chairman of the Topical Committee on the Allocation of Production, American Petroleum Institute, suggested that the principles and factors of allocation developed by that committee probably would permit the same degree of participation in a restricted pool "as would have resulted by prudent and diligent operation under unrestricted flow—with probably greater protection from drainage and damage from neighboring leases." More specifically, Hardwicke [48] has given in simple language his studied view of the terms "law of capture" and "law of oil in place." The following has been briefed from and is the essence of his more detailed statement:

> The so-called "rule of capture", which is recognition of title to oil produced from a well, exists in every State. Until the State exercises its police power, an owner of land may drill in any way he may elect, and the only recourse of an adjoining landowner is to protect his property by offset wells. In theory, at least, the offset wells virtually confine the oil of each man to his own property. As long as a man is free to do as he chooses, he can in a measure protect himself. When government restricts his freedom to act to protect his property, the rule of capture becomes inoperative, except to the extent that a man uses what comes out of his well. The law of capture is not necessarily inconsistent with that of ownership in place, and a constitutional amendment is not needed to establish better rules for protection of property. Adjacent operators have certain quantities of oil and gas underlying their respective properties. An equitable proration or allocation

[47] Wood, Fred E., Essential Engineering Factors in the Allocation of Production; Revised Progress Report of the Topical Committee on the Allocation of Production: Drilling and Production Practice, 1934, Division of Production, Am. Petrol. Inst., 1935, p. 8 (reprint, p. 2).

[48] Hardwicke, Robert E., discussion following paper by Wyckoff, R. D., The Relation of Well Potentials, Sand Permeability, and Well Pressures to Allocation of Production, Drilling and Production Practice, 1934: Division of Production, Am. Petrol. Inst., 1935, pp. 18–22 (reprint, pp. 12–16).

order is in effect a plan of operating procedure to prevent undue drainage without the necessity of the neighboring landowners engaging in an offset drilling campaign.

Wyckoff [49] expressed a somewhat similar thought when he said:

> Thus, under such regulatory statutes (restricting the right of operators to protect their own property from drainage) the State must assume the obligation of maintaining the privileges which were formerly enjoyed under the law. This can be done easily by proper application of the several component factors of a reasonable allocation plan.

Few persons will contend that the rule of capture as applied in the past history of the industry has resulted in other than uneconomic conditions. Although in theory protective drilling may tend to restrict to each property owner the oil and gas within the confines of his subsurface holdings, actually the possibility of movement across property lines is well-recognized. Not infrequently the abuses of offset drilling, sometimes resulting in ruthless tactics to encourage cross-property drainage, have caused premature exhaustion of the reservoir energy and depletion of the oil and gas reserves and have led to costly lawsuits. Even when offset drilling has been done with more or less tacit accord an unnecessary density of wells on both sides of the property line has raised the production costs for each operator to totals out of all line with development requirements.

Despite the evident disorder that has resulted from this rule that grew out of a condition where scientific knowledge was lacking it is worth while to observe what may result by interpreting and applying the rule in the light of present knowledge. It is possible that such a course of action may lead to a desirable state of stabilization and permit the taking of oil and gas from a pool in an orderly manner. The desirable objective is to accomplish this with minimum cost of wells drilled to the producing horizons through a program of optimum well spacing and with reduced operating costs through full utilization of energy in the reservoir system, thereby prolonging the flowing life of the field.

Engineering knowledge has established the fact that the maintenance of correct pressure gradients between wells prevents cross-drainage, premature water encroachment, shifting of the gas cap, and other changes detrimental to proper pressure conditions within the reservoir. In effect, this suggested concept of the reconcilability of the rule of capture and the rule of ownership in place, combined with an allocation formula based upon sound engineering principles, may be the means of operating an entire pool for the optimum benefit of all concerned regardless of diversified ownership and not as separate parcels with no apparent relation to one another. In this way many of the same objectives would be accomplished as if the pool were under one management in some form of unit operation.

RELATION OF TECHNOLOGY TO FUTURE ECONOMIC CONDITIONS

The allocation order of March 25, 1935, applied to the North Dome of the Kettleman Hills field, is a recent development that exemplifies how economic, legal, and Government policies are affected by technology. Although the evident interest of drivers of motor vehicles and many others still is centered in the price they have to pay for gasoline and lubricants, nevertheless, the effect upon them of the

[49] Wyckoff, R. D., work cited. (See footnote 48.)

outcome of these newer allocation methods, such as that applied to the Kettleman Hills field, may be far greater than they realize. Surely the interests of land owners, royalty owners, and other groups having direct relation with oil-producing properties will be affected as definitely (even if to a smaller degree) as the interests of the operators themselves.

It has been stated repeatedly that many major problems of the petroleum industry can be traced to the inequitable, wasteful, and antisocial results of the rule of capture as it has been applied. Assuming this premise to be substantially correct it is reasonable to suppose that a definite step toward stabilization and the formulation of a wise national policy of oil conservation can be made if the principles of ownership in place and ratable taking can be applied and remain consistent with the revised interpretation of the property law of capture. Moore [50] has shown aptly that proper understanding of property rights is requisite to developing and enforcing equitable allocation plans, and the courts eventually will have to rule on various points of issue. However, courts of today have access to knowledge of characteristics of oil and gas and their behavior in reservoirs that was not available to the judiciary bodies that initiated the concept of reduction to possession. As allocation of production on a recognized engineering basis does no violence to the legal concepts of property it seems reasonable that these newer interpretations of ownership in place, which are in accord with this new view of the rule of capture, will receive support of the courts and of all other component groups that comprise the public interest in oil.

At some future time, now indeterminable on the basis of present knowledge, there will come a period in which there will be a dearth of oil. The present requirements of restricted production will change, but the industry and the Nation will require efficient withdrawal and use of the remaining reserves. The lessons learned now in applying scientific knowledge of fluid and energy relations to obtain ratable taking of the greatest ultimate recovery of oil and gas should be of inestimable value in meeting the conditions of that new era.

[50] Moore, T. V., work cited (see footnote 28).

NATURAL GAS[1]

By H. S. Kennedy and H. C. Fowler

SUMMARY OUTLINE

The natural-gas industry has attained its present economic and social position in this country because of its ability to supply energy in a convenient form. Its importance is realized better from the estimate that natural gas now supplies approximately 10 percent of the total energy derived from all fuels and water power. Available statistics indicate that the amount of natural gas marketed in the United States during 1934 reached 1,950,000,000,000 cubic feet, about 25 percent more than the quantity marketed in 1933 and slightly greater than the previous all-time high in 1930.

The reasons for this increase in the use of natural gas and its effect upon civil and industrial life throughout the country call for careful analyses of the several major uses, as the results reveal certain important trends that relate to business recovery.

Figure 69 shows graphically the steady growth in consumption of natural gas from 1921 to the peak of 1930 (1,943,421,000,000 cubic feet). After 1930 the total marketed production of natural gas declined rapidly through 1933, due largely to the effects of the general business depression upon industrial use and to curtailed field development which shut off a sizable outlet for the fuel in drilling oil and gas wells. However, the domestic and commercial demand did not follow the trend of total consumption but remained at almost the same level as that reached in 1930, indicating well-established uses for natural gas in cooking and heating which were not influenced appreciably by depressed conditions.

The curve for marketed production of natural gas turned sharply upward in 1934, increases in consumption being recorded for all major uses. Gas for drilling and the development of power for other field requirements showed the greatest increase of the several major uses. The estimated field consumption was 710,000,000,000 cubic feet, or

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

about 44 percent more than in 1933. This exceptional rise in field use was due primarily to the larger number of wells drilled in 1934, which is reported as 18,273 compared with 12,312 in 1933. With the oil industry drawing heavily on known reserves for the past several years and with the discovery of only the field at Conroe, Tex., since the "bringing in" of the East Texas area, it is natural that renewed drilling activity should result from the quest for additional sources of oil supply. These conditions, augmented by the fact that the number of wells drilled in 1934 approaches the average of the last 10-year period (about 20,700 wells per year), suggest that a sustained consumption of gas for field use may be expected, at least for the immediate future.

General industrial consumption, including public-utility power plants, also gained decidedly in 1934. The American Gas Association recorded a total volume of 575,414,500,000 cubic feet for these uses. This increase of 31 percent over 1933 may be attributed partly to a general upturn in industrial activity and partly to the success of the natural-gas industry in its organized plan to increase off-peak loads through the development of additional industrial outlets.

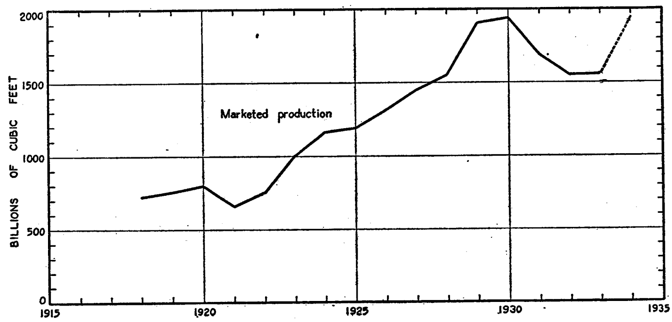

FIGURE 69.—Marketed production of natural gas, 1918–34. The figure for 1934 is subject to revision.

The domestic and commercial use of natural gas in 1934 showed only a slight gain over 1933; the total for the year was approximately 370,000,000,000 cubic feet. The industry has built up domestic consumption through sales efforts to supply gas for house heating, refrigeration, incineration, and water heating, and the fact that the volume so used has remained relatively constant for several years indicates that, allowing for normal local fluctuations in the areas now supplied, no appreciable expansion in this type of service may be expected unless new types of markets are developed or new centers of population served.

Carbon-black plants utilized 229,933,000,000 cubic feet of natural gas in 1934. This volume represented an increase of nearly 21 percent over 1933 and accounted for nearly 12 percent of the total natural-gas distribution in 1934. Frequently the manufacture of carbon black has been considered as an inferior use of natural gas compared to its utilization as fuel, but it fulfills a unique role in relation to the natural-gas industry. Although the product is the basis of many essential articles, tires and ink being the most important, the economics of its manufacture prevent plants from operating in areas of high-priced natural gas. Frequently, as demand for gas as fuel develops in an area, the carbon-black operators are forced to move their plants to new oil and gas fields where cheap, excess supplies of gas are available. Thus it appears that to a degree the carbon-black industry has acted as a consumer of excess gas which otherwise would have been wasted. In this connection it has been pointed out [2] that those concerned with the control of waste natural gas in the Texas Panhandle had considered the possibilities of extending the carbon-black industry to provide a market for the excess gas being blown to the air.

The use of natural gas by petroleum refineries is estimated at 69,000,000,000 cubic feet in 1934, an increase of about 4 percent over the 1933 level, which broke the downward steady decline of this type of consumption begun in 1928. Despite the increase in domestic demand for all refined products except wax still-gas production dropped approximately 2 percent in 1934 compared with 1933. If the 4-percent increase in natural-gas consumption and the 2-percent decrease in still-gas production are compared on a B. t. u. basis the explanation of the upturn in the curve of natural gas consumed at refineries is apparent, as the additional natural gas was used to make up the deficiency in refinery gas. In this connection it is important to note that refiners use first the fuel products from their own plants for which there is no immediately available market, such as refinery gases and acid sludge, and their purchased fuels are then chosen on a price basis. Accordingly, natural gas competes directly with other purchased fuels for refinery use.

The value of natural gas at points of consumption was approximately $405,000,000. This 10-percent increase over 1933 can be attributed entirely to the increase in volume delivered to consumers, as the general trend of natural-gas rates was downward. The lowering of rates has resulted partly from the action of State regulatory bodies. More important, however, is the fact that natural gas usually is in competition with other fuels, and each distributing company must maintain and, where possible, increase its constant load and number of consumers. This is accomplished most directly with low rates, made possible by the extension of market outlets and increased efficiencies in operation. If the volume of pipe-line throughput is increased and the consumption curve flattened, using existing facilities to increase capacity by developing greater off-peak industrial loads, the operating costs are lowered. Part of these savings can be passed on to the consumers in lower rates.

After 2 years of decline there was an impetus to the drilling of new gas wells in 1934 that resulted in an upturn in field developments and the opening of new sources of supply, although no fields of major significance were discovered. The number of gas wells drilled during 1934 is reported as 1,385, an increase of nearly 49 percent over 1933. "Dry" gas areas are not the only sources of supplies for the industry. A large volume of gas is made available through the development of oil-bearing properties. It is estimated that 55 percent of the marketed natural gas is produced with oil. The natural-gas industry has virtually no control over when or how this gas will reach the surface and take its place in meeting the fluctuating seasonal and load demands. Nevertheless the drilling of 12,563 oil wells during 1934, an increase

[2] Hopkins, G. R., Kennedy, H. S., and Fowler, H. C., Memorandum Regarding the Natural-Gas Industry; Prepared by the Bureau of Mines at the request of the Chairman, Committee on Interstate and Foreign Commerce, House of Representatives, Dec. 20, 1934; published in H. Rept. 827, pt. 4, 73d Cong., 2d sess., pp. III–XXIV.

of 55 percent over 1933, exerts a substantial influence upon the natural-gas-producing capacity of the country.

No interstate natural-gas lines were built during the year; construction was confined to short transmission lines and gathering lines for gasoline plants. Reference to specific work that has been reported through the courtesy of State officials and others assisting in the preparation of this chapter is given in the following review by States of natural-gas activities during 1934.

REVIEW BY STATES

Arkansas.—The Arkansas Board of Conservation issued five permits to drill wells in the Paleozoic area of western Arkansas, according to information supplied by George C. Branner, State geologist. Three wells in the Vesta field, in sec. 13, T. 8 N., R. 29 W., Franklin County, developed open flows from 750,000 to 7,500,000 cubic feet with pressures from 220 to 525 pounds per square inch. A small well, Hughes No. 1, in sec. 14, T. 15 N., R. 26 W., Madison County, was completed in the Cotter dolomite at 933 feet, with a production of 250,000 cubic feet and a pressure of 125 pounds. The gas from this well is being used locally.

A well drilled to 3,100 feet on the Ada anticline, sec. 6, T. 5 N., R. 17 W., Conway County, was abandoned as a dry hole.

Permits were issued to plug and abandon 1 well in Franklin County, 3 in Crawford County, and 1 in Yell County.

California.—Natural-gas production in California is related closely to and influenced definitely by the oil-producing activities of the State. This condition is shown clearly by detailed information made available through the courtesy of Claude C. Brown, chief engineer, Railroad Commission, State of California.

Of the 643 wells drilled during 1934 only 9 were for gas production alone. Curtailment of oil production has had a very decided effect upon the total number of wells drilled each year since 1929, when 910 were completed. A low of 184 wells were completed in 1932, and there was some gain in 1933. In 1934, completed wells for oil and gas totaled 452, Long Beach leading the list with 83 wells and Mountain View being second with 49.

Two new gas fields were developed during the year. The Edison field in Kern County, paralleling the prolific Mountain View field, had 11 completed wells at the end of the year, after completion of the discovery well at 3,065 feet. Two oil- and gas-producing horizons (the Duff at 2,200 feet and the Temblor below 3,000 feet) have been developed. The first producing well in the Kettleman Hills Middle Dome was completed at a depth of 7,846 feet. This well had an initial production of 1,500 barrels of 55° A. P. I. gravity oil and 30,000,000 cubic feet of wet gas per day. The pressure shown on the casinghead gage was 1,250 pounds per square inch. About 1,169 acres are included within the proved area of this field under the Kettleman Middle Dome Corporation agreement of the four participating companies, and the indications are that the reservoir contains large quantities of natural gas.

Other developments in the San Joaquin Valley included recent completion in the South Belridge field at a depth of 11,377 feet, producing from a thickness of 177 feet of sand from the Carneros zone, which gave definite indications of high gas pressure. In November 1934 a wild-cat well was begun on the Madera-Merced County line near the town of Chowchilla. This well now is producing large quantities of gas and oil from a depth of 8,000 feet in Cretaceous rock. New gas-producing wells have been drilled in the old Buena Vista Lake bed (producing 8,000,000 cubic feet per day from 5,250 feet) and at McKittrick, both in Kern County.

Although no wells were drilled, thousands of acres were leased to develop new sources of natural gas in the Semitropic gas field. This structure, paralleling the Buttonwillow dry gas field, was discovered some 20 years ago, but two wells drilled about 10 miles apart which proved the existence of great quantities of gas were abandoned because there was no market for the gas. Several years ago another well drilled into this structure to a depth of 5,000 feet was abandoned because high gas pressure wrecked it completely.

Southern California was also active. A well completed at 3,850 feet and making 800,000 cubic feet of wet gas per day indicated that additional reserves of gas had been opened in the Inglewood field.

Northward along the coast the larger operators in the Ventura Avenue field are seeking deeper zones of both oil and gas, and at Goleta near Santa Barbara new gas zones have been tapped. The Capitan field west (and north) of Elwood also is under development.

From this review of drilling activity and discovery it is evident that the known and producing gas areas in California were augmented substantially during 1934. The accompanying tables based upon figures supplied by Claude C. Brown chief engineer, Railroad Commission, State of California, give the production, utilization, and wastage of natural gas in California in 1934 compared with 1933.

Salient statistics of the natural-gas industry in California, 1933–34 [1]

Use	1933		1934		Percent of change in 1934 from 1933
	M cubic feet	Percent of total	M cubic feet	Percent of total	
Repressuring and storage	6,204,800	2.3	[2] 3,852,800	1.4	−37.9
Gasoline plant, fuel, and shrinkage	51,088,400	18.9	[3] 47,586,300	16.9	−6.9
Field fuel	38,381,100	14.2	[4] 38,510,200	13.7	+.3
Other fuel (refineries)	4,995,000	1.9	[5] 7,041,200	2.5	+41.0
Sales to utilities and others	157,206,600	58.2	167,644,300	59.6	+6.6
Blown to the air	12,183,600	4.5	16,720,000	5.9	+37.2
Total net production [6]	270,059,500	100.0	281,354,800	100.0	+4.2

[1] Figures compiled by Claude C. Brown, chief engineer, Railroad Commission, State of California.
[2] Used largely in the Midway-Sunset (Buena Vista Hills) and Dominguez fields.
[3] Greater part used in Long Beach field where 11 extraction plants are in operation.
[4] Greater part used in Kettleman Hills and Long Beach fields.
[5] Distributed generally.
[6] "Net production" is the difference between total gross production and quantity of gas recirculated. Figures represent net quantity of gas taken from wells.

Sales of natural gas to utilities and others and number of consumers in California, 1934 [1]

	Number of consumers	M cubic feet
Sales to consumers:		
Domestic and commercial	1,446,565	58,464,555
Industrial	5,012	57,926,659
Utility uses:		
Gas plants and compressors		3,040,601
Electric plant fuel		26,417,660
Unaccounted for		10,914,208
Total utility uses		156,763,683
Total nonutility uses		10,880,617
Total sales	[2] 1,454,754	167,644,300

[1] Figures compiled by Claude C. Brown, chief engineer, Railroad Commission, State of California.
[2] Includes 3,177 miscellaneous consumers.

Brown points out that at the end of 1934 there was no production from the Buttonwillow and Goleta fields as both of these dry gas reserves were shut in. It has been estimated that Buttonwillow can produce 20,000,000 cubic feet per day and Goleta half that quantity.

The 31 active producing fields contained 92 gasoline-extraction plants with an output of 505,690,000 gallons of natural gasoline in 1934. There are no carbon-black plants in California.

Although the figures show an increase of 37.2 percent in the quantity of natural gas blown to the air in 1934 compared with 1933 actually the quantity represents only 5.9 percent of the total gas produced, a very satisfactory proportion in view of conditions within the State before effective operation of the gas conservation act of May 28, 1929.[3]

Natural-gas waste in California is low because of (1) the careful administration of the gas-conservation laws of the State, and (2) the growing desire on the part of the producers to conserve the gas pressure in the deeper horizons for the purpose of lifting oil.

There was virtually no waste of dry gas, and the total quantity was almost entirely casing-head gas produced in conjunction with oil operations. The Huntington Beach field was responsible for 65 percent of the gas wasted in the State during 1934, or nearly 11 billion cubic feet. In this field there was feverish activity in whipstock (deflection) drilling of the tidelands along the shore line of the Pacific Ocean that led to extended litigation, but the condition is now under control. The difference between conditions pertaining to waste in uncontrolled "town-lot" areas and in fields where the acreage is controlled in large blocks by relatively few operators and development is being done in accordance with an efficient and conservative plan is shown by the fact that the gas blown to the air in the Huntington Beach field in 1934 represented 41.7 percent of the total field production of 26,173,350,000 cubic feet, whereas in the north dome of the Kettleman Hills field the wastage for the year was only 2.4 percent of the total field production of 115,728,506,000 cub c feet.

There have been no important natural-gas lines laid in the State since 1932. It is significant that two lines from Kettleman Hills to

[3] Federal Oil Conservation Board, Report V to the President of the United States, October 1932, appendix VI, pp. 47-50. Miller, H. C., and Lindsly, Ben E., A Report on Petroleum Development and Production, Petroleum Investigation: Hearings before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, H. Res. 441, pt. 2, pp. 1243-1244.

San Francisco, 20 to 22 inches and 24 to 26 inches in diameter, with carrying capacities of 75,000,000 and 125,000,000 cubic feet per day, respectively, are operating at a load factor of 85 percent, and any substantial growth of market in the Bay region will call for additional fuel supply.

The heat content of natural gas produced in California ranges from 960 to 1,250 B. t. u. per cubic foot, the general average for all natural gas served being 1,150 B. t. u. per cubic foot.

Colorado.—Information on Colorado natural-gas operations has been supplied by H. J. Duncan, supervisor, United States Geological Survey. The Craig field in Moffat County produced 48,000,000 cubic feet of gas in 1934, which was distributed for domestic use at Craig. The Berthoud field in Laramer County supplied 19,200,000 cubic feet to a public-utility pipe line. The Garcia field in Las Animas County east of Trinidad produced 54,000,000 cubic feet of gas, all of which was processed through a natural-gasoline plant in the field; the residue gas was used for fuel in the field.

The following gas fields in Colorado are shut in because pipe-line facilities and markets are lacking: Bell Rock, Moffat County; Garmesa, Garfield County; Model Dome, Las Animas County; Piceance Creek, Rangely, and White River, all in Rio Blanco County; and Thornburg, in Moffat and Rio Blanco Counties.

There was an estimated loss of 1,352,000,000 cubic feet of noninflammable carbon-dioxide gas from the North McCallum field in Jackson County during a 6-month experimental period of production.

The same general marketing conditions pertain to the natural-gas industry within the various States of the Rocky Mountain district, as centers of population are widely scattered and limited. The gas industry also is faced with keen competition from the coal industry, and most of the large potential revenue centers are surrounded by coal fields. The increase in industrial and domestic consumption in future will thus be limited unless gas can be delivered at a cost less than coal.

Illinois.—According to a review of the gas situation in Illinois prepared by Alfred H. Bell, geologist and head of the Oil and Gas Division, Illinois State Geological Survey, no commercial gas wells were drilled in the State in 1934. In southeastern Illinois, which in the past produced most of the State's oil and gas, the gas production is now very low. The gas that is produced is processed for natural gasoline and the residue gas used as a source of power for oil-field machinery. One small gas well was drilled on the Stubblefield anticline in Bond County, and the gas was utilized in drilling an oil test well. Greenville obtains its natural gas from the Ayers field 5 miles to the north and is the only town supplied with natural gas produced within the State. It is noteworthy that Illinois, once a producer of large volumes of natural gas, now depends upon supplies brought by long-distance pipe lines from other States to fulfill the requirements of its extensive markets. Virtually no natural gas is wasted, as it is in great demand for use as fuel.

Indiana.—Drilling for natural gas in Indiana continued at about the same rate in 1934 as in 1933, according to information furnished by J. P. Kerr, State gas supervisor. There were 35 gas wells drilled during 1934, of which 26 were in old fields and 9 in the Oakton field, northwestern Knox County, in the southwestern part of the State. Although discovered 4 years ago this field was not developed until

1934 and is reported for the first time as a new field. The Oakton field now has 13 completed wells, each of approximately 1,500,000 cubic feet open-flow capacity, producing from around 600 feet in the lower Pennsylvanian formation. In December 1933 a small pipe line was constructed from this field to two small towns in Illinois, and 18 million cubic feet of gas produced from two wells was transported through the line in 1934. At present preparations are being made to construct a 6-inch pipe line from the field to a mixing plant at Terre Haute for mixing the gas with manufactured gas, the product to be distributed in south central Indiana. It appears likely that this outlet will absorb the field's production. In fact, this project indicates a material increase in consumption from the Oakton field in future and is leading to a continued field-development program.

The Alford gas field in Pike County, largely developed before 1934, had three completions during the year, which increased the supply about 10 percent. Gas from this field is distributed in the southwestern part of the State, mostly for domestic purposes. Five gas wells were completed in the Hudsonville field in southeastern Daviess County. Gas from this field is consumed for domestic purposes, and as the present markets in that area take all available supplies activity in exploration for gas is concentrated around the Hudsonville field.

Pipe-line extensions were made to Boonville, Linton, and Evansville; also, lines were extended from the northeastern part of the old Trenton field in Jay County to Union City, Winchester, and Portland. However, the several wells to which these extensions were connected declined late in the year, and connections had to be made to a public-utility transmission line to meet the demand. Such arrangements are a great advantage from a conservation standpoint in obtaining the ultimate production from small and declining reserves of local gas, as deficiencies in supply can be met through connections to lines from large fields.

In the southern part of the old Trenton field five additional wells were completed; also, a number of old wells were cleaned out to augment the local domestic market of nearby towns. In Decatur County alone there are about 300 wells, 20 percent of which supply gas solely to the farms on which they are drilled.

The Unionville field which has been developed in eastern Monroe County is still without a market, although a considerable potential volume has been developed. The Harrison County field, which obtains its production from the New Albany black shale, showed little activity. The operators in this field are watching their rate of production carefully; this is not done generally throughout the State, as in some fields the wells are "pulled" at a rate tending to hasten their ultimate exhaustion.

About 100 million cubic feet of gas were lost during 1934, due principally to worn-out equipment in wells and old pipe lines. This condition is especially true in the old Trenton area. Considerable gas was also lost by blowing salt water from wells in the declining Francisco field. Two wells in Decatur County and two in Perry County which were without pipe-line outlets lost relatively large volumes of gas. In many of these older areas the general problems of waste are different from those in newer, more prolific fields. Questions of cost face the operators, and frequently the expense necessary to replace old equipment might result in the abandonment of wells and even pipe lines.

The total marketed production of natural gas in 1934 was 1,350,000,000 cubic feet, of which about 90 percent was used for domestic and commercial purposes. Use in the field and by a small glass factory and several clay plants accounted for a limited industrial consumption.

Kansas.—Three new gas fields—Orth, Sharpe, and Beyer, all in Rice County—were discovered in Kansas during 1934. Twenty-six gas wells were drilled, and five others produced large volumes of gas with oil. Many wells completed as oil wells also produced some gas. Kenneth K. Landes, assistant State geologist of the State Geological Survey of Kansas, points out that an increasing number of gas-reservoir rocks of upper Pennsylvanian and lower Permian age are being discovered in central and western Kansas.

The State legislature recently passed three new laws which will have an important bearing on the conservation of natural gas. Marvin Lee, technical adviser of the State corporation commission, estimates that 50 to 75 million cubic feet of natural gas is being wasted daily because gas produced with oil, chiefly from Mississippian lime wells, has no present market. State officials hope that one of the new laws, which permit the commission to establish oil-gas ratios depending upon conditions in each field, will reduce this waste and otherwise bring about further gas conservation. A large quantity of gas is without a market in western Kansas, and it is expected that some pipe lines will be built soon. There are no carbon-black plants in the State.

A report to the Kansas State Planning Board, entitled "Kansas Natural Gas", prepared by W. K. Cadman, gives a history of the development and marketing of natural gas in Kansas. This report contains estimates showing that the Hugoton gas field in the southwestern part of the State is one of the major gas fields of the world. The estimates of production range from 8 to 10 trillion cubic feet. An important lesson which other States may observe with benefit is drawn as to the use of their natural-gas resources. The plentiful supplies developed in the earlier period of the natural-gas history of Kansas attracted many industries which later were lost because the natural fuel supply diminished and became scarce. Kansas again is in a position to attract industrial development by reason of a new and abundant supply of natural gas. The newly enacted conservation laws indicate that the State authorities are looking toward the conservation of this new supply with the view of utilizing it to the greatest advantage of the State.

Two short gas lines were constructed from the Burrton gas field in Reno County, one to the nearby town of Burrton and a 10½-mile line to a State institution at Hutchinson.

Louisiana.—Natural-gas production in Louisiana was 227,920,363,000 cubic feet in 1934, according to information supplied by Cyril K. Moresi, State geologist of Louisiana. This quantity is an appreciable gain over production in 1933. Louisiana has 26 distinct areas that produce natural gas, and drilling in many parts of the State did not reveal any new gas fields in 1934. A total of 46 gas wells was completed, of which 31 were drilled in Monroe and the other 15 in 8 other old fields.

The Rodessa field in Caddo Parish and the Sligo field in Bossier Parish became increasingly important producers during 1934. The only gas pipe line constructed was an additional line from the Rodessa field to the main line of a public-utility distributing company. In the Cameron Meadows oil field 3 gas wells were completed, and in the Roanoke oil field 1 gas well was completed. Most of the gas in these oil fields was used in development work.

Gas burned for carbon black totaled 51,333,382,000 cubic feet, which produced 67,026,665 pounds of carbon black. Gas treated for natural gasoline amounted to 63,000,880,000 cubic feet, which produced 32,835,573 gallons of gasoline.

Most of the south Louisiana oil fields produce some gas with the oil, which is used as fuel in drilling, but no statistics are available on this production.

Engineers of the department of conservation have conducted pipe-line-leakage surveys in the Monroe and Richland areas, and as a result many improvements have been made which have reduced waste of gas from this source to a minimum. Inspection of approximately 1,000 producing gas wells showed that most of them had been repaired and obsolete equipment replaced. Siphons for removing salt water also had been installed where needed. The general repair work and installation of new equipment have reduced gas wastage to a small quantity. Control of the crater wells existing formerly in Monroe and Richland has extended the life of these fields many years. Although no figures are available, in general the waste of gas from Louisiana fields is believed to be small and is due to pipe-line and underground loss.

Michigan.—There was a marked increase in natural-gas activity in Michigan during 1934, resulting in a total production of 3,008,085,000 cubic feet according to figures compiled by F. R. Frye, petroleum engineer, department of conservation, State of Michigan. Compared with similarly reported production for the State in 1933, this volume represents an increase of 77 percent. The following review of developments in Michigan is based upon information furnished through the courtesy of R. A. Smith, State geologist, and R. B. Newcombe, petroleum geologist for the department of conservation.

At the end of 1934 there were 977 oil wells and 110 gas wells producing within the State. During the year 469 wells were completed, of which 150 were dry holes; this suggests the large amount of unsuccessful exploratory drilling through the glacial drift of the State, sometimes 500 or more feet thick, required to find favorable structures capable of producing oil and gas. There were 272 oil wells completed and 47 gas producers. Of the gas wells, 36 were drilled in old fields and 11 in new fields. Active development took place in the new Edmore (Montcalm-Mecosta) area. This productive trend of the Michigan "stray" formation, estimated to include 10,000 to 12,000 acres, is in Belvidere (T. 12 N., R. 7 W.), Horne (T. 12 N., R. 6 W.), and Richland (T. 12 N., R. 5 W.) Townships, Montcalm County, and Hinton (T. 13 N., R. 8 W.) and Millbrook (T. 13 N., R. 7 W.) Townships, Mecosta County. The producing capacities of the wells are 1 to 8 million cubic feet per day from the "stray" sands at about 1,300 feet. Drilling in this field has proceeded slowly because there is no pipe-line outlet, although some gas has been used for drilling purposes. A production of about 4 million cubic feet was reported from 11 gas wells within the area, which also contains 4 oil wells.

The Broomfield field, Isabella County, with 4 gas wells (and 1 oil well) produced over 1¼ billion of the 3 billion cubic feet reported for the State in 1934. Important extensions were made to this field to the northeast and northwest into Sherman Township (T. 15 N., R. 6 W.). The wells were not large, but the rock pressure was almost the same as the original rock pressure in the older parts of the field.

The Mount Pleasant and East Extension oil field rated second in the State, with a production of over one-half billion cubic feet of gas.

The Austin gas pool, Mecosta County, was extended one-half mile east and northeast by the completion of three new wells. Gas from this pool is now serving both Big Rapids and Muskegon. The cities of Muskegon and Muskegon Heights were connected to the wells in December 1934, causing an increase in production from this field to a total of 178,552,000 cubic feet for the year. The Muskegon oil field, with 24 gas wells and 132 oil wells, produced 452,136,000 cubic feet.

The Clare gas field, Clare County, with 7 wells, still is unconnected to an outlet; and the Elba gas field, Gratiot County, with 4 wells drilled to a shallow formation of about 500 feet, has been disconnected because of water troubles in the wells.

The Vernon area in Isabella County, which is actually an oil and gas field with 52 oil wells and 15 gas wells, produced 285,617,000 cubic feet during 1934. This field was extended slightly to the south into Isabella Township (sec. 1, T. 15 N., R. 4 W.). A small separate pool west of this district in Vernon Township (sec. 31, T. 16 N., R. 5 W.) and Gilmore Township (sec. 36, T. 16 N., R. 5 W.) had 2 new wells in 1934 and 2 being drilled.

Scattered new supplies were found in the synclinal area between the Austin field and the older Broomfield field. Two small wells, not yet connected with pipe lines, produced gas from a Michigan series gas horizon 50 to 60 feet higher stratigraphically than the regular Michigan "stray" sand. These two wells indicate the existence of scattered shallow pools in the district, but the reserves cannot be predicated on the basis of structure.

Waste from the Michigan gas fields is small, as wells without a market are shut in. After the initial open-flow tests, all subsequent tests of the capacities of the wells to produce gas are made by the Bureau of Mines "back-pressure" method. The prevention of waste is enforced through the oil and gas conservation law in accordance with the rules and regulations of the Michigan public utilities commission covering the production, transmission, and distribution of natural gas (order 2883, effective Nov. 20, 1934).

Some gas has been wasted in the oil fields, but proration in the flush Porter pool, Midland County, which produced over two-thirds of the State's quota of oil in 1934, has reduced the waste appreciably. At present a new casing-head plant with a rated capacity of 5,000,000 cubic feet per day is taking most of the gas from the independent producers. The residue is piped through a 6-inch line to Midland for use in a chemical manufacturing plant. The natural-gasoline plant is not operating at capacity. At least one company is not delivering to the gasoline plant but is recycling its casing-head gas in oil-producing operations. With a total of 282 oil wells in the field large quantities of the casing-head gas have been used in the field for drilling. Gas going to the air is burned in risers.

The only other natural-gasoline plant in operation is in the Mount Pleasant and East Extension oil field, which, as has been stated, rated second place in gas production with over one-half billion cubic feet. The plant has a rated capacity of 3,000,000 cubic feet of wet gas per day. At present it is running at about half capacity. The dry residue gas is returned to the field for repressuring.

As has been indicated, the main gas horizon so far discovered is the Michigan "stray" sand. Although occurring at various depths it is relatively shallow, the original reservoir pressure is low, and the consequent reserves per acre are comparatively small. Availability of the gas and the question of longevity of specific fields have had an important bearing upon the economic considerations of extending pipe lines, except to small cities in the local areas where studies have shown that the required investment has been warranted on the basis of the known reserves.

The 8-inch line from the Broomfield field serving cities in the eastern part of the Southern Peninsula becomes quite complicated in the network of distributing extensions around Saginaw and Bay City. The capacity of the line is about 7,500,000 cubic feet per day. Pressure at the field meter house at Broomfield is 210 to 220 pounds per square inch, at Midland 150 to 175 pounds, and at Saginaw and Bay City 115 pounds.

The town of Clare is now served by a 2-inch line from the Vernon field, which may be changed to 4-inch, and a 4-inch line runs south to Mount Pleasant which has a capacity of 2,000,000 cubic feet per day at a working pressure of 180 pounds per square inch. Usually a pressure of 150 to 165 pounds per square inch is carried at the wells and field regulating stations and of 40 pounds at the city gates, which is reduced to 10 pounds per square inch in the distributing mains.

The 4-inch line from the Austin field to Big Rapids has a capacity of 2,000,000 cubic feet. The pressure at the field regulator is 250 pounds per square inch and in the city mains 12 pounds. An 8-inch line now connects the field with Muskegon. This line has an estimated capacity of 10,000,000 to 15,000,000 cubic feet per day.

Mississippi.—The Amory and Jackson gas fields produced 9,170,130,000 cubic feet—the total natural-gas production in 1934 for the State of Mississippi, according to information supplied by George C. Swearingen, State oil and gas supervisor.

The Amory field which was discovered in 1926 produced 163,901,000 cubic feet in 1934 from three wells. The volume and pressure have declined, and during the cold winter months the supply could not meet the demand. The total production of the field from discovery has been approximately 1,300,000,000 cubic feet.

There were 10 producing wells and 1 dry hole drilled in the Jackson field during 1934, making a total of 114 producing wells out of 178 wells drilled in the field. The new drilling has increased the proved area to approximately 7,500 acres, and the present open-flow capacity of the field is about 4,150,000,000 cubic feet. Production during 1934 was 9,006,229,000 cubic feet, of which 18 percent was used for domestic, 11 percent for commercial, and 71 percent for industrial purposes. Total production from discovery in 1930 to the end of 1934 was 34,837,868,000 cubic feet. There are no carbon-black plants in the State, and as the gasoline content of the gas is low there are no gasoline plants.

Missouri.—There were 45 gas wells completed in Missouri during 1934 with a total open flow of about 12,000,000 cubic feet, according to information submitted by H. S. McQueen, assistant State geollogist. The Marota pool in sec. 17, T. 49 N., R. 32 W., Jackson County, was opened as a commercial pool, although it had produced shallow gas for private use for many years. Nine producing wells and four dry holes were drilled. The main production is from the Squirrel sand, although some gas was found in the black shales which are productive in many areas. Gathering lines connect the pool to a public-utility pipe line. The West Granview pool in sec. 3, T. 47 N., R. 33 W., Jackson County, in which 4 wells were drilled in 1933 had a total of 12 producing and 7 dry holes drilled at the end of 1934. Most of the production comes from the Peru sand, and the pool is connected by gathering lines to a public-utility pipe line.

Montana.—According to information supplied by H. J. Duncan, supervisor, United States Geological Survey, the total production of natural gas in Montana was 15,020,613,000 cubic feet in 1934. Of this quantity, about 11,400,000,000 cubic feet were sold for domestic consumption and 3,600,000,000 cubic feet consumed by the smelters at Great Falls and Anaconda, the sugar-beet refinery at Chinook, and in other industrial plants. No carbon-black plants are operating in this State. Production from the various fields and the cities to which the gas was transported are given in the accompanying table.

Production and distribution of natural gas in Montana, 1934 [1]

Source		Destination	Quantity delivered, cubic feet
Field	County		
Bowes	Blaine	Havre and Chinook	433,446,000
Boxelder	Hill	do	412,206,000
Bowdoin	Phillips	Malta, Glasgow, Fort Peck, and other towns	417,050,000
Cedar Creek	Fallon	Miles City and Glendive, Mont.; Rapid City, S. Dak.; Marmarth, Bowman, Bismarck and Williston, N. Dak.; and intervening towns.	6,014,680,000
Cut Bank	Glacier	Cut Bank, Helena, Butte, Anaconda, and intervening towns.	5,049,666,000
Dry Creek	Carbon	Bozeman	200,000,000
Hardin	Big Horn	No estimate of amount consumed for domestic use.	
Kevin-Sunburst	Toole	Shelby, Great Falls, and intervening towns	2,046,208,000
Whitlash	Liberty	Great Falls and intervening towns	447,357,000
			15,020,613,000

[1] Data supplied by H. J. Duncan, supervisor, U. S. Geological Survey, Casper, Wyo.

A total of 20 miles of 8¼-inch pipe was laid from Glasgow, Mont., to the Fort Peck Dam now under construction on the Missouri River. This extension has increased the market for gas from the Bowdoin field in Phillips County by about 70,000,000 cubic feet per month. In the Kevin-Sunburst field, Toole County, a new extension approximately 12 miles long, of 4-inch pipe, connects a refinery with a group of newly drilled gas wells on the east side of the field. An average of 12,000,000 cubic feet per month is transported through this line from seven wells.

New Mexico.—There were 13 gas wells completed in New Mexico in 1934. The new Cooper area in Lea County was opened with the drilling of No. 1 Myers in NE., NE., SE., sec. 24, T. 24, R. 36. This well flowed 50,000,000 cubic feet of natural gas at a depth of 3,438 feet, but when it was deepened to 3,512 feet an oil well of 5,400 barrels per day resulted. This discovery led to a drilling campaign, and 23 oil wells and 1 gas well were completed, making available a large potential reserve of gas in connection with the oil developments. The pool is north of the Jal field and south of the Eunice pool, and later completions between the Cooper area and the Jal field indicate that these two areas are one continuous pool. The Jal field continues to be the most important gas producer in the State; and the discovery of this new potential supply in the Cooper area, connecting with the Jal field, will make larger reserves available for the pipe line supplying El Paso and extending to Tucson and Phoenix, Ariz. One gas well was completed in the Jal field.

One gas well, No. 2 State-McDonald, was completed in the Eunice pool. Upon plugging back from 4,350 to 3,850 feet the well produced 27,000,000 cubic feet at 3,150 to 3,850 feet. This is another indication of the potential gas reserves available in the area, which is of interest primarily for its oil production.

A 26-mile pipe line was built from a connection with the Jal-El Paso line to Carlsbad to obtain an additional supply of 6,000,000 cubic feet. A 20-mile lateral line was built to connect with the main pipe line in the southeastern corner of Eddy County to the potash refinery near Loving.

Information on gas production in the northwestern part of the State was furnished by H. J. Duncan, supervisor, United States Geological Survey. The Blanco area produced 16,496,000 cubic feet, which was supplied to Aztec, N. Mex. The Kutz Canyon area in San Juan County produced 713,938,000 cubic feet, which was utilized in Santa Fe and Albuquerque, N. Mex. The Ute Dome area of San Juan County produced 446,755,000 cubic feet, which was utilized in Durango, Colo., and Santa Fe and Albuquerque, N. Mex.

New York.—Drilling for new gas supplies in New York was only moderately active during 1934, most of the development taking place in the southern tier of counties where several of the fields extend across the State line into the northern tier of counties of Pennsylvania, according to Frank Brewster, president and general manager of the Belmont Quadrangle Drilling Corporation, Bradford, Pa. However, there was some exploratory drilling in other parts of the State, and 1 of the 2 areas listed as new gas fields by Brewster was in Camden Township, northwestern Oneida County, where 2 wells have been drilled and are producing from the Trenton limestone at comparatively shallow depths of about 1,050 feet. At the end of the year four other wells were drilling in the area. The other new field is the Willing field in Allegany County, and the production comes from the Oriskany sand at a depth of about 4,840 feet. The Willing field has 4 producing gas wells, 1 dry hole, and 2 wells drilling.

The following discussion on developments in different parts of New York State is based upon information furnished by C. A. Hartnagel, assistant State geologist. Outside of the old productive fields exploration for natural gas was carried on in 12 counties, where 56 wells were drilled of which 15 were productive.

Hartnagel reports that 6 wells were drilled in Allegany County during the spring and summer of 1934 and 4 others were drilling at the close of the year. Three were in the town of Allen, and each was about 3,000 feet deep; two were dry, and the third had a production of 150,000 cubic feet. Two wells in Willing Township in the southern part of the county had productions from the Oriskany sandstone of 9 and 4 million cubic feet, respectively, and a well in Independence penetrated the Oriskany at 5,042 feet, but only salt water was found.

Two deep tests were completed in Cattaraugus County near the Pennsylvania State line. One of the wells, in Olean Township, reached the top of the Oriskany sandstone at 4,276 feet and was drilled to a total depth of 4,295 feet. A show of oil but no gas was reported in the Oriskany. The other well, in Allegany Township, reached the top of the Oriskany at 4,357 feet and was drilled to a total depth of 4,385 feet, but no gas was found. In western Cattaraugus County, New Albion Township, a test to the Medina was completed at 3,992 feet, but no gas was found, and the Oriskany was reported absent.

In Steuben County 8 wells were completed during the year of which 5 were in the town of Greenwood in the southwestern part of the county. Of the Greenwood wells, 2 proved to be large producers, 14 million and 7 million cubic feet, respectively, but the other 3 found only salt water. All 5 wells were drilled to depths ranging from 4,180 to 4,946 feet and were completed in the Oriskany sandstone. The other 3 wells were drilled to shallower depths in the central and northwestern sections of the county, and each proved unproductive.

No new wells have been drilled in the shallow Rathbone field, and the supply of gas has failed.

In northern Cayuga County five shallow wells were completed in the towns of Conquest and Cato. The first well produced 2½ million cubic feet from the Niagara limestone at a depth of only 450 feet with 180 pounds pressure. Two other wells showed small production, but one was abandoned as dry and the other showed only a small quantity of gas in the Medina. In the town of Aurelius a well was drilled into the Medina at a depth of 1,815 feet with a small flow of gas.

Four wells have been drilled in Lewis County 5 miles west of Lowville and 6 or 7 miles from the pre-Cambrian border of the Adirondacks. The productive formation is the Trenton limestone at 880 to 1,200 feet, where gas occurs at several horizons. One of the wells, a dry hole, was drilled to the pre-Cambrian, which was reached at a depth of 1,473 feet. The best of the 3 producing wells had a rock pressure of 455 pounds per square inch and a daily flow of 368,000 cubic feet. A 4-inch pipe line has been constructed from the wells to the village of Lowville.

In the Geneva field, Ontario and Seneca Counties, 18 additional wells were drilled, only 3 of which found production. In all, 67 wells have been drilled in the field, of which 35 were originally listed as producers. Of these, 23 have been connected with the pipe lines—19 in the Geneva field proper and 4 in what is known as the "East block." The remaining 12 wells which had original flows were not placed on the line because of small volumes or early exhaustion. The 19 wells in the Geneva field proper, which were placed on the pipe line, delivered 30 to 40 million cubic feet of gas in 2 months. This withdrawal of gas reduced the pressure of the wells to that of the transmission line (40 to 50 pounds per square inch). The 4 wells in the eastern block recently have been placed on the line, and withdrawals thus far indicate that the gas recovered will exceed the entire output of the large group of wells in the original Geneva field.

Two wells were completed in the town of Bristol, Ontario County, west of the Geneva field, of which one was dry and the other had a daily production of 425,000 cubic feet of gas. Both wells were bottomed in the Medina formation at depths of 2,661 and 2,900 feet, respectively.

Eight wells were drilled during 1933 and 1934 near the village of Clyde, Wayne County. All these wells passed through the relatively shallow Niagara and Medina formations and were bottomed in the Trenton limestone at depths ranging from 2,700 to 3,400 feet. No gas of importance was found in the Niagara or Medina formations, but large temporary flows were found in the Trenton. After being shut in 6 weeks the first well showed on official test a rock pressure of 1,900 pounds per square inch with a flow of 2,245,000 cubic feet. Five other wells were drilled within a radius of one-fourth mile from the first well, and one of these was dry. The other four wells had large initial flows, but in a few months the flows and pressures in all of the wells had become so low that the wells were not connected to pipe lines. Two other wells were drilled in the Clyde area in 1934. One of these, south of the group of closely spaced wells, was dry and the other 1½ miles north of the group had a large initial production but soon failed.

In the Wayne-Dundee field, only one or two new wells have been drilled during the last year. In the western, or Wayne, section of the field, many wells that were closely spaced have failed. In the eastern section, which is controlled by a single company, production has been maintained through operation of an economic plan for withdrawal of the gas. Outside the Wayne-Dundee field one or two additional wells have been drilled to the Oriskany sandstone but without results.

Shallow tests have been made in Monroe and Tioga Counties. A small production was found in the Tioga test. In Broome County a well was drilled in the town of Lisle to a depth of 3,250 feet. No Oriskany formation was present, and no gas was obtained.

The productive horizon in the wells near Camden in northwestern Oneida County is the Trenton limestone, in which gas is found at several different horizons. The first of the completed wells was drilled to a depth of 1,175 feet, and after it was closed in the flow was about 500,000 cubic feet with a pressure of 710 pounds per square inch. The second well struck a flow of gas of 1,725,000 cubic feet at a depth of about 1,100 feet, 80 feet below the top of the Trenton.

Ohio.—Information on natural-gas activities in Ohio was supplied by A. E. Faine, statistician of the Independent Gas Producers' Association of Ohio. Natural gas was produced in 60 different counties in 1934 from 7,500 gas wells. Drilling activities in 1934 resulted in 487 producing gas wells distributed over 37 counties, according to a compilation of the Division of Mines of Ohio.

The most important shallow-sand development in recent years is the Pultney Ridge field in Guernsey County, which was developed largely during 1934. The proved area of 1,770 acres has been outlined by the drilling of 54 gas wells, 48 of which were completed in 1934. Production was found in 11 feet of the first Berea sand at an average depth of 1,420 feet. The initial rock pressure was 585 pounds per square inch, and the open flows ranged from a few thousand to 5,000,000 cubic feet, averaging 1,350,000 cubic feet. A small oil production has been found on the southern edge, but the gas area is virtually defined.

The economic history of natural-gas supply and demand in Ohio is typical of many other States. At one time Ohio had developed immense supplies of natural gas and extensive domestic and industrial markets where this fuel was used. Many of the gas fields now are nearing exhaustion, and of necessity the State must import about 45 percent of its marketable demand. It is true that many gas wells in Ohio are shut in part of the time, but if all of the wells of the State were drawn upon for any long period of time a sustained production could not be maintained to meet the peak demand of winter, which is about five times the summer demand. Therefore, to assure continuing supply at all seasons, the utility companies import gas from neighboring States to meet the franchise requirements prescribed by the State utility commission.

Oklahoma.—There were no dry gas fields developed in Oklahoma during 1934, according to William J. Armstrong, proration umpire for the State of Oklahoma. There were 91 gas wells drilled in old areas which augmented the present declining supply of natural gas within the State. A considerable volume of gas was developed in connection with oil production, but a large part of this gas will be required for the development and production of oil. Large gas flows were mudded off in reaching the oil production developed in the Fitts pool of Pontotoc County. However, this gas probably will be required for oil development as in other oil fields of the State.

The waste of dry gas during the year was of small consequence, as the State statutes prohibit the production of dry gas for stripping it of gasoline. However, these statutes do not apply to gas produced with oil, much of which is wasted after the gasoline is extracted. The State authorities encouraged gas-purchasing companies to take gas produced with oil in place of dry gas, but in spite of this, much gas has been wasted in such fields as Oklahoma City.

Only one carbon-black plant, at Sayre, is in operation in the State. A permit has been issued to build a carbon-black plant in Texas County of the Oklahoma Panhandle, but it has never been built. It is against the policy of the State authorities to permit carbon-black plants where a fuel market exists.

Bills have been introduced in the State legislature to consolidate the conservation and proration departments with a view to making their work more effective, thus aiding in the prevention of waste of oil and gas.

Pennsylvania.—A preliminary tabulation of natural gas produced in Pennsylvania in 1934, by Henry W. Van Pelt, director, bureau of statistics, department of internal affairs, shows a total of approximately 84,000,000,000 cubic feet compared with 71,527,836,000 cubic feet in 1933. This increase of 17 percent is accounted for largely by the activity in the Potter County field. There also was some drilling in Tioga County, but the activity in that area did not cause the increased production.

Frank Brewster, who reported on southern New York State, also has reported two new gas fields for northern Pennsylvania, both in Potter County and both producing from the Oriskany sand. The Harrison field in the southwestern corner of Harrison Township had 1 gas well and 1 well drilling. The well open-flowed 25,000,000 cubic feet per day from a depth of 4,745 feet.

The other new area is known as the "Ellisburg field" in south central Genesee and north central Allegany Townships. There are 9 wells in the field, 1 of which is a dry hole, and 6 additional wells drilling. The open-flow of the producing wells is given as 25,000,000 cubic feet and the producing depth as 5,200 feet.

In the older fields Brewster reports 4 additional gas wells for the Tioga field and 15 gas wells and 2 dry holes for the Hebron field.

S. H. Cathcart, chief geologist of the Pennsylvania Geological Survey, reporting on the Oriskany-sand gas fields of northern Pennsylvania, has stated that since discoveries made in Tioga County in 1930 and Potter County in 1931, 6 Oriskany sand fields have been developed in the State, 5 of which are in Potter County. The Farmington and Hebron fields were responsible for substantial increases in production in 1934, but no additional wells were drilled in the Farmington field. New wells drilled in the Hebron area had initial ratings of approximately 14,000,000 cubic feet per day, and the field was extended southwest about 2½ miles.

In addition to the new successful drilling in Potter County reported by Brewster, drilling to the Oriskany sand was carried on in northern Bradford, McKean, Cameron, Lawrence, and Butler Counties. These deep tests were not successful in opening new gas-producing areas. Some interest, based upon geologic structure and other evidences, has been shown in the possibility of deep production in northwestern Pennsylvania.

Although the exact number cannot be reported, there are probably 16,500 natural-gas wells in Pennsylvania. Many are small producers. In addition, small quantities of gas are produced with oil, but this gas is needed for lease operations and does not contribute appreciably to the domestic and industrial market. Pennsylvania is typical of a State where once more gas was produced than could be consumed. Today it could consume many times the quantity it is capable of producing, and every new gas field is important to the economic welfare of the State.

South Dakota.—Natural gas has been produced in South Dakota for about 30 years but only in small quantities. According to E. P. Rothrock, State geologist, there have been no new developments in the gas industry during 1934. Gas is produced from shale beds, and although the volume is small the wells have a long life. The only commercial production is in the cities of Pierre and Fort Pierre, where the gas is produced in conjunction with hot artesian water from private and municipally owned wells. The consumption in those towns is entirely local.

Texas.—Field activity in 1934 increased greatly over that in 1933 as shown by the completion of 279 gas wells compared with 140 in 1933. The old gas-producing areas of the State were active, many wells being completed.

The southwestern part of the State had 87 gas wells completed and showed more new gas discoveries than any other area in the State.

The Caesar field in northern Bee County was opened by No. 1 Pullin in the F. Lewis Survey for 25,000,000 cubic feet of gas in the Pettus sand at 3,007 to 3,032 feet. Subsequently the completion of No. 4 Ruhman at 3,054 feet with 114 barrels per day proved this field to be oil-productive. A new gas area was opened in the northern part of Duval County by the completion of No. 1 Labee in Survey No. 2 for 30,000,000 cubic feet in the Hockleyensis formation at 2,460 feet. A new shallow gas area also was discovered in the northwestern part of Duval County by the completion of No. 1 Duval County Ranch Co. in Survey 192. The well had a flow of 15,000,000 cubic feet at a depth of 1,505 feet. In Karnes County a new gas field was opened by the drilling of No. 1 M. E. Choate in the Johnson Survey by flowing 25,000,000 cubic feet from the Pettus sand at 3,325 feet. The Lopeno field in southwestern Zapata County was opened by the drilling of No. 1 R. Ramirez in Block 4 for 20,000,000 cubic feet in the Mount Selman formation at a depth of 2,042 to 2,062 feet. The limits of the Agua Dulce field were extended 1 mile south by the drilling of No. 1 Walton, which flowed 40,000,000 cubic feet of gas and 40 barrels of distillate at a depth of 4,775 feet. A new sand was discovered in the Laurel field, Webb County, by the completion of No. 12 Laurel, flowing 20,000,000 cubic feet at a depth of 1,770 to 1,777 feet.

In the Gulf coast drilling was very active; 70 gas wells were completed. The Eureka Heights field was opened in Harris County by the drilling of No. 1 Laura Lackner in the H. Reinermann Survey for 8,500,000 cubic feet of gas and 25 barrels of distillate in the Cockfield sand at 7,686 feet. A new gas field was opened in the northern part of Victoria County by the drilling of No. 1 Midgett, sec. 14, T. & N. O. Survey in the Frio sand at a depth of 2,847 feet. The Tomball field in Harris and Montgomery Counties was very active, and 19 gas wells were completed in addition to 81 oil wells. An extensive network of gas-gathering lines has been laid covering the whole Conroe field to bring gas to various gasoline recovery plants. A 20-mile line of 10- and 8-inch pipe has been laid from the Conroe field to Huffman Station where it connects to a public-utility trunk line extending from northeastern Texas to Houston.

In the West Texas district five gas wells were completed in previously developed fields.

Twelve gas wells were completed in the East Texas district. An important extension was made to the Long Lake gas field in Anderson County by the drilling of No. 1 Miller, in the S. Sanchez Survey No. 10, for a flow of 50,000,000 cubic feet after plugging back to 5,281 feet. This well is 2½ miles from the nearest well in the Long Lake field, and the extension will add a potential reserve of appreciable magnitude to that field. The Long Lake field was connected to market during the year by the construction of 72 miles of 12-inch welded line to Reisel Station near Waco, McClennan County, where the lateral joins a large public-utility pipe-line system. An important discovery was made in Freestone County by the drilling on the P. D. C. Ball lands in the J. I. Auguilera Survey of a well which flowed 10,000,000 cubic feet after being plugged back to a depth of 4,865 feet. The Leon County gas area, discovered in 1933 in the J. Carter Survey, remains unconnected by pipe line with a public-utility outlet. A gas well on the Lee farm, Cooper Survey, has been brought in which is considered to be on a separate structure from the other two wells in the area. An important discovery was made by the No. 1 Davey and Royall in the M. Rogers Survey. The well flowed 50,000,000 cubic feet at 5,041 feet, and more gas and distillate were found at 5,045 feet.

The East Texas field is covered by a network of gas gathering and return lines to bring gas from more than 6,000 wells to 20 casing-head gasoline plants. The plants have a daily capacity of more than 100,000,000 cubic feet. The gasoline content is 2 to 3 gallons per thousand cubic feet, although the gas from several gas wells in the south end of the field is not as high in condensable fractions. Eventually most of the gas from the gasoline plants will be sent back by the return lines which have been provided to repressure the wells as the bottom-hole pressure declines.

North Central Texas had 44 gas wells completed during the year. There were no outstanding developments.

The Texas Panhandle was fairly active, 58 gas wells being completed. The most important development in the area was the attempt of the gas companies and the State authorities to stop the waste of gas from gasoline stripping plants, which amounted to 1,600,000,000 cubic feet per day at the end of 1934. Initital steps that have been taken to change the statutes pertaining to the gas situation in the Texas Panhandle indicate that the State legislature realizes the importance of controlling this waste if the field is to continue as a major gas reserve, and corrective legislation probably will be enacted.

Utah.—An important new gas field was discovered on the Last Chance structure in Emery County, according to information supplied by E. W. Henderson of the United States Geological Survey. The well measured 21,000,000 cubic feet at the time the sand was tested and had a rock pressure of 410 pounds per square inch. Plugging back from deeper drilling to 2,773 feet reduced the open flow to 2,400,000 cubic feet with an indicated rock pressure of 480 pounds per square inch. The decline in volume is believed to be due to the procedure followed in plugging back. The well is shut in at present, but consideration is being given to utilizing the gas for smelting aluminum ores from deposits near Marysville, Utah, which would require construction of a 75-mile pipe line.

A gas test in the old Clay Basin field of Dagget County developed a large and important gas reserve in a formation not previously tested. As the well is approximately 15 miles from the Salt Lake City line it is likely that connection eventually will be made with that service.

The total production of natural gas in Utah in 1934 was only 37,441,000 cubic feet, which was used entirely for domestic purposes. The area is one where competition for fuel markets is keen, with good local coal available at relatively low prices, and the prescribed marketing schedules for natural gas have tended to retard production and development of natural gas within the State.

Development of carbon dioxide gas is handicapped by the cost of transporting the products to market. A considerable local industrial market has been developed in the use of carbon dioxide gas for blasting purposes, and sales in the liquid form resulted in a production of 38,434,000 cubic feet.

Washington.—Information on natural-gas developments in Washington have been prepared by Glover under the direction of Harold E. Culver, supervisor of geology, Department of Conservation and Development.

The Rattlesnake Hills field, Benton County, continued to supply gas from 15 wells to Grandview, Granger, Mabton, Sunnyside, Toppenish, Prosser, and Zillah. Gas production from that field in 1934 was 141,137,000 cubic feet from the basalt at a depth of 750 feet, with one well at about 1,000 feet. The original pressure was 32 ounces, but now the gas must be pumped with the pressure below zero. No new wells were drilled during 1934, and work was suspended at 1,870 feet on a test which was intended to penetrate the unknown rocks below the basalt in an endeavor to discover the source beds of the gas.

During the last 40 years many wells have been drilled in Whatcom County, and a number have shown important flows of gas at shallow depths. Recently, 6 gas wells were drilled in the Shallow Gas field 6 miles north of Bellingham. An attempt was made to utilize this gas locally through a small pipe line, but water and loose sand presented difficulties, and operations were discontinued. The desirability of testing thoroughly the gas possibilities of Whatcom County has been studied because of the favorable gas showings and the extensive markets available in the Puget Sound region. An important indication in this respect is the Lange No. 2 well, which showed a heavy gas flow with 350 pounds pressure at 1,345 to 1,365 feet. Salt water resulting from drilling difficulties interfered with a determination of its full possibilities, but gas from this well is being used locally. Results of the Lange test are leading to further prospecting of the deeper horizons of the region.

Tests are under way in other parts of the State, as in Grant County on the Frenchman Hills anticline and near Wenatchee where encouraging quantities of gas have been found. A test well, Rosalie No. 1, near Forks in Clallam County, drilled to 2,350 feet had a large volume of gas at high pressure which was confined by the heavy rotary mud.

The natural-gas developments in Washington have encouraged further prospecting. Procedure laid out for the future is based on careful geologic work with indications that natural gas may be produced in larger quantities.

West Virginia.—A report on natural-gas developments by R. C. Tucker, assistant State geologist, indicates that 274 gas wells were drilled in West Virginia in 1934, with a total open flow of 124,398,000 cubic feet. Gas production for the State was approximately 95,000,000,000 cubic feet, or about the same as in 1933. About 16.8 percent was distributed for domestic and commercial consumption, 17.6 percent was for industrial use, and 63.4 percent was exported to other States where the distribution is unknown. The remaining 2.2 percent was accounted for by line loss. West Virginia has production capacity from about 12,700 wells and apparently could supply larger markets if they were available, as 2,500 gas wells have been shut in most of the time during the last several years. This developed capacity permits the State to supply gas to distant markets in other States which do not possess natural-gas resources or whose natural-gas supplies have been partly exhausted and are now below their market requirements.

From a national standpoint this surplus permits conservation of the natural-gas resources of States whose supplies have dwindled below their market requirements. Thus small supplies can be used to their extractable limit, and the balance of the market requirements can be made up from gas transported through long-distance pipe lines from large fields in other States.

No trunk pipe lines were constructed during 1934, but many feeder lines were extended to connect new wells. There are no carbon-black plants in the State.

Gas is widely distributed in West Virginia; the wells drilled in 1934 were located in 23 counties. With reference to new developments, David B. Reger, consulting geologist, Morgantown, W. Va., reported that a well drilled to 600 feet in the Big Injun sand with a production of 600,000 cubic feet indicates revival of deeper production on the old Burning Springs anticline at Petroleum in Grant district, Ritchie County, where previously even shallower production was found. A new gas discovery was made when several gas wells were drilled in the Proctor district near Maud, Wetzel County. Deep production has been developed in the Benson sand by the drilling of 3 gas wells in the Meade district, Upshur County. Drilling activity of considerable extent resulted in the completion of 17 new gas wells with open flows from 500,000 to 1,500,000 cubic feet in the McComas district, Cabell County. A new gas area was opened with the drilling of several wells near Slab Fork in the Slab Fork district, Raleigh County. A development within the city limits of Welch has resulted in the completion of 20 small gas wells of low pressure.

Operators are looking with favor on the acid treatment of lime production wells, and in some instances the gas production has been increased tenfold.

Wyoming.—Information on the natural-gas situation in Wyoming has been submitted by H. J. Duncan, supervisor, United States Geological Survey. The total gas production in 1934 was approximately 26,000,000,000 cubic feet, which was slightly under the production of the previous year. A new gas field was opened on the Walker dome by the drilling of a well in NE¼ sec. 8, T. 46 N., R. 99 W., sixth principal meridian, with an initial open flow of 1,000,000 cubic feet from the Frontier formation. At present the field lacks a market and pipe line; owing to these reasons and the apparent limited reserve there is little prospect for additional development at this time.

A new supply of gas was developed in the Oregon Basin field from one well in SW¼ sec. 9, T. 50 N., R. 100 W., sixth principal meridian, with an initial flow of 7,600,000 cubic feet. It is believed that the geological structural condition is a distinct fault block with gas accumulation. An extension line has been laid from the well to the Oregon Basin-Cody gas line.

An 8-inch line has been extended from Medicine Bow to Rock River, connecting the Allen Lake field with the pipe line to Laramie.

The only carbon-black plant operating in the Rocky Mountain district is in the Lance Creek field, Wyoming. Shortage of gas at various times has hindered operations. Whether or not the use of gas for carbon black in this field is the best use of the gas is questionable, but available markets are distant, and even then the possible outlets would be very small. Conditions have not warranted domestic use of this gas.

An estimated 500,000,000 cubic feet of gas was lost in Wyoming in 1934 due to blowing water from wells, miscellaneous leaks, and drilling-in losses. This loss is small compared with the total gas produced. In general, operations in all Rocky Mountain States are well-conducted, and waste of gas is normal in connection with oil-field practices as they are conducted today. Stopping waste is a supervisory function of the State and Federal offices in the Rocky Mountain district, supported by various State and Federal laws.

FACTORS AFFECTING GROWTH OF THE INDUSTRY

The important statistics showing the position of the natural-gas industry in 1934 and the review of recent developments in the several natural-gas-producing States which have been given in this chapter direct attention to the broader, over-all view of this industry. Some suggestions have been given as to the causes of existing conditions, as revealed by the preliminary figures, and possible immediate effects upon the industry and the social economy, also as to the influence being exerted by the producing abilities of the fields in different States. As a further necessary requisite in considering the outlook of the natural-gas industry, a brief survey should be made of several factors that have contributed to its rapid development.

In the early years of the industry the distribution of natural gas was confined to areas near the gas fields. This local distribution was due to conditions at that time. The development of most gas-producing fields has been incident to efforts to find new oil fields. Many of the gas fields, especially in the Eastern States, were adjacent to industrial centers that consumed all the gas that could be supplied readily, or manufacturing plants grew up near the fields on established routes of transportation because of the availability or peculiar suitability of the fuel, as, for example, in glass-making and the manufacture of ceramic products. If the fields producing both oil and gas were in isolated sections little effort was made to develop markets for the excess gas, and the quantity not used in developing the oil properties or at nearby refineries was wasted. Pipe used in the fabrication of pipe lines was of small diameter and capable of withstanding only relatively low pressures. Thus, the industrial and social status at that time and the lack of technical development limited the economic distribution of natural gas to short distances, even when excess supplies were temporarily available.

The subject of reserves and continuing supply was not given the serious study that subsequent developments have shown would have been advisable; when the local gas fields declined in their production and the price increased because of high production costs many users had to turn to other fuels. These conditions deterred the growth of the industry throughout the period when distribution was restricted mainly to supplying current needs from adjacent fields. Potential users, both domestic and industrial, were reluctant to invest in gas-burning equipment necessary to change over to this fuel, with the prospect that the supply would not be permanent.

A decided change in fuel economics followed the discovery of large, high-pressure fields in the Southwest. Nearby markets could take only a very small part of the available gas, whereas urban and industrial centers at a distance were in need of these immense and assured supplies. The major problem then was to connect these supplies with calling markets by means of improved and economical methods, as before 1925 the delivery of gas over 250 miles from its source was an outstanding engineering achievement. Metallurgical research, to meet this definite need, resulted in the making of steels suitable for the fabrication of high-pressure pipe lines of large diameter, and, concurrently, advances in the welding art made it possible to join the lengths of pipes into continuous lines capable of transporting gas at working pressures of 600 and more pounds per square inch for distances as great as 1,000 miles with little attendant leakage.

The blocking out of large reserves of high-pressure gas and means provided for transporting the gas to distant markets gave assurance that investments would be amortized. Accordingly the industry received a forward impetus by reason of the availability of money to finance these projects. Another factor that aided growth was the interconnection of long-distance pipe lines with distributing systems formerly supplied entirely by gas from low-pressure areas. If the local supply of gas became scarce or would not meet peak demands, it could be supplemented as needed. The advantageous practice of interchanging sources of supply has been pointed out in the review of conditions in several of the States. This development has been a guarantee of uninterrupted and continued supply never before enjoyed by many users of natural gas and has resulted in extending service to many new consumers, as distributing companies were in a position to develop new markets by assuring an unfailing supply of fuel.

The net result of these several conditions has been expansion of the natural-gas industry in proportion to its ability to supply fuel on a highly competitive basis. The number of domestic consumers in 1934 is estimated at about 7,500,000. Of this total, approximately 5,500,000 used straight natural gas, and the remaining 2,000,000 were consumers of mixed gas. The domestic consumption of natural gas represents a population of over 32,000,000 persons living in 35 States and the District of Columbia, who are served through collecting, transporting, and distributing lines having an estimated length of 150,000 miles.

A natural-gas industry is now established with a capital investment variously estimated at $2,000,000,000 and upward, which occupies third place as a supplier of fuels, the per-capita consumption of which is greater in the United States than in any other country.[4]

In recent considerations of future progress of the industry doubt has been reiterated as to the effect of waste upon the long-continuing supply of this natural fuel. Probably at no previous time has so much studied attention been given to estimating fuel reserves. The effect of waste on supplies of natural gas has been brought forcibly to the attention of the country by the outstanding example of the Texas Panhandle, where at the end of 1934 gas blown to the air is reported to have reached 1,600,000,000 cubic feet per day. If permitted to continue at that rate reserves capable of supplying established markets for 40 to 50 years may dwindle to a producing life of only a fraction of that time. The gas-producing companies have been active in

[4] Creveling, J. D., A Brief History of the Natural-Gas Industry: Natural Gas, vol. 16, no. 5, May 1935, p. 5.

attempting to stop this waste, and legislative steps have been taken in an effort to control the conditions which make possible the "stripping" of dry gas of its small percentage of gasoline fractions and blowing the processed gas to the air.

Reports from the various States indicate that the natural-gas industry is too well aware of the need of conserving its assets to waste willfully the product it can sell. Practices conducive to gas waste, as in the Texas Panhandle, and in the manufacture of natural gasoline are not subject to the control of the natural-gas producing, transporting, and distributing companies. A recent study of "unaccounted-for" items on reports to the Bureau of Mines by major distributors indicates that this loss, including leakage throughout the whole distribution system to the consumers' meters, is about 4 percent of the total quantity handled. Although this quantity of gas is an appreciable item of expense to the operating companies, it is of minor significance compared with gas produced and never delivered into pipe lines.

Another element affecting the future of the natural-gas industry is the tendency of the oil industry to use an increasing volume of the gas produced with oil in its own operations; advancements in petroleum technology have shown the advantages to be derived by controlling pressure gradients in the reservoirs and making the gas do its maximum work in bringing the oil from the underground reservoirs to the surface. Moreover, returning gas to the oil-producing formations for increased-recovery programs will lessen the present availability of this gas as fuel. Eventually, most of this recycled gas should reach a market as fuel, but the unknown time factor of its ultimate delivery into pipe lines will affect immediately available supplies.

Although various estimates have been made of known gas reserves and on these bases computations have suggested the possible duration of the known supplies at present rates of consumption there is definite feeling by those who have studied the problem seriously that there are undeveloped and undiscovered sources of natural gas to supply new and extended markets. When general business conditions warrant, new lines probably will bring additional gas to waiting markets where, as in the past, it will take its place as a competitive fuel.

Because of its characteristics natural gas is a preferred fuel for various uses and for certain classes of consumers who can afford to pay for its convenience. Indications are that the industry will emphasize in its sales programs the development of these outlets for its product.

Predictions of future trends always are beset with the possibility of overlooking some major influence or of the development of some new and unsurmised condition. However, if due weight is given to the statistical facts that have been presented and if the potential supplies are considered in relation to undeveloped markets to which the gas can be transported because of technical developments, it is reasonable to suppose that the natural-gas industry will continue to grow. It is improbable that there will be another sharply rising peak, but the consumption curve should increase gradually, with minor fluctuations, in keeping with the position of natural gas as a preferred fuel for many uses.

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NATURAL GASOLINE [1]

By G. B. Shea

SUMMARY OUTLINE

A definite upturn in refinery demand after 4 years of decline gave the natural-gasoline industry a more optimistic outlook. Refinery takings of natural gasoline for blending in motor fuel in 1934 were higher in nearly all districts compared with 1933, and the total refinery consumption increased 12 percent or to 1,132,152,000 gallons. The rise in refinery consumption in 1934 was due almost entirely to gains in the second half of the year, as consumption in the first half was only slightly higher than in the comparable period of the preceding year. The increased demand for natural gasoline is traceable to a number of influences, including a gain of 3.8 percent in motor-fuel production and a general trend throughout the country toward more volatile motor fuels. Evidence of a shift to greater utilization of natural gasoline as a builder of volatility appeared in the Mid-Continent area, and there was a stronger tendency for the large integrated companies to turn more of their natural-gasoline production into crude-oil pipe lines for delivery to refineries.

Production of natural gasoline during 1934 increased moderately. The output was 1,521,100,000 gallons, a gain of 101,100,000 gallons (7.1 percent) compared with 1933. The increase in output, however, was by no means general, and while substantial gains were recorded in some fields production in other areas continued to drop. An important factor that maintained its influence on natural-gasoline production in many fields was the curtailment of the supply of "wet" natural gas through the operation of State and national crude-oil proration programs. The rise in output for the entire country was due principally to abnormal activity in natural-gasoline plants in the Texas Panhandle area, where, under the provisions of the sour-gas law, operators are permitted to extract the gasoline fractions from the natural gas and blow the residue gas to the air. Since the passage of the "stripping" law by the Texas Legislature early in 1933 the output of natural gasoline from the Panhandle area has mounted

[1] Detailed figures for 1934 including final revisions are given in the Statistical Appendix to Minerals Yearbook, 1935.

steadily, and the waste of natural gas has grown to such proportions as to attract national interest.

The trend of prices and market fluctuations followed the usual seasonal pattern, with periods of low prices and general adverse conditions which caused dissatisfaction, especially among many independent natural-gasoline manufacturers. In June 1934, under the weight of increasing stocks resulting from increased production and low refinery demand, prices dropped to within one-fourth cent of the 1933 all-time low for natural gasoline prices in the Mid-Continent area. The accustomed seasonal upswing in refinery

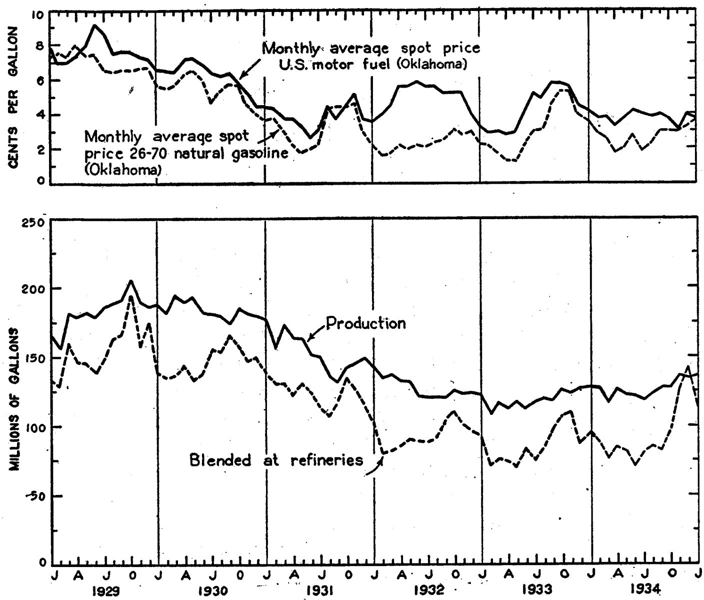

FIGURE 70.—Trends of production, blending at refineries, and prices of natural gasoline, 1929–34, by months.

purchases in preparation for the winter supply of more volatile motor fuels began in July, and the marked firmness developed in the market extended into the winter 3 months beyond the usual end of the peak refinery buying period.

Improvement in the demand for natural gasoline became pronounced in the last months of the year. The rise in consumption was rapid through October and November, and in November refinery takings reached their highest point since November 1930. The current output did not supply the refinery demand, which in November exceeded production by about 6 percent.

Salient statistics of the industry are summarized in the following table, and principal trends are shown graphically in figure 70.

Salient statistics of the natural-gasoline industry, 1933–34

[Thousands of gallons]

	1933	1934 [1]	Percent of change in 1934
Production:			
Appalachian	56,300	54,700	−2.8
Illinois, Kentucky, and Michigan	8,400	8,100	−3.6
Oklahoma	360,500	356,500	−1.1
Kansas	24,900	27,100	+8.8
Texas	366,500	463,400	+26.4
Louisiana	37,000	41,800	+13.0
Arkansas	15,200	12,800	−15.8
Rocky Mountain	54,900	58,500	+6.6
California	496,300	498,200	+.4
Total production	1,420,000	1,521,100	+7.1
Stocks:			
At plants Jan. 1	18,840	[2] 41,664	
At plants Dec. 31	27,584	36,100	+30.9
Net change	+8,744	−5,564	
At refineries Jan. 1	115,416	[2] 112,896	
At refineries Dec. 31	111,468	120,960	+8.5
Net change	−3,948	+8,064	
Total, Jan. 1	134,256	154,560	+15.1
Total, Dec. 31	139,052	157,060	+13.0
Net change	+4,796	+2,500	
Total supply [3]	1,415,204	1,518,600	+7.3
Distribution:			
Blended at refineries:			
East coast	46,578	54,894	+17.9
Appalachian	9,954	11,928	+19.8
Indiana, Illinois, Kentucky, etc	74,970	98,616	+31.5
Oklahoma, Kansas, and Missouri	208,656	246,708	+18.2
Texas Inland	142,968	171,318	+19.8
Texas Gulf coast	105,504	95,340	−9.6
Louisiana Gulf coast	11,928	9,702	−18.7
Arkansas, and Louisiana inland	17,094	22,596	+32.2
Rocky Mountain	34,398	33,726	−2.0
California	358,428	387,324	+8.1
Total blended at refineries	1,010,478	1,132,152	+12.0
Blended at plants	5,505	(4)	
Run through crude-oil pipe lines in California	54,054	50,652	−6.3
Exports, sales to jobbers, etc	198,618	197,946	−.3
Losses	146,549	137,850	−5.9
Total distribution	1,415,204	1,518,600	+7.3

1 Subject to revision.
2 New basis.
3 Production plus or minus change in stocks.
4 Revised method of reporting does not include this item.

ECONOMIC DEVELOPMENTS

Wide seasonal variations in refinery demand for natural gasoline, with correspondingly wide fluctuations in prices, have been an unstabilizing influence in the natural-gasoline market for the past decade. A troublesome effect of the seasonal variation is recurrently to cause the entrance of distress natural gasoline into the retail market directly as motor fuel, where it competes with refinery gasoline and depresses the price structure of motor fuel. Solution of the problem necessitates cooperation between refiners and natural-gasoline manufacturers, and although efforts have been made from time to time to solve the industry's difficulties they have achieved little tangible result.

Although the Code of Fair Competition for the Petroleum Industry includes no provisions for protection of the natural-gasoline business, it is recognized that natural gasoline constitutes a definite part of the total motor-fuel supply and that efforts toward market stabilization would be helpful.

An outstanding development, therefore, was the establishment of Committee J, which gave the natural-gasoline industry representation on the Planning and Coordination Committee in connection with the development of a program of stabilization wherein due consideration is to be given to natural gasoline in motor-fuel allocations. The following resolution was adopted by the Planning and Coordination Committee:

Whereas, a large surplus of natural gasoline has resulted from the absence of a reasonable market thereby impeding the entrance and obstructing the movements of this commodity in interstate commerce and,

Whereas, the sale of natural gasoline at subnormal prices which are not responsive to the factors of supply and demand and in many cases are below the actual cost of production has disrupted the interstate market for other gasolines and motor fuels, and,

Whereas, the continuance of a surplus will cause storage loss, evaporation and militate against conservation of a fugitive, volatile and irreplaceable natural resource.

Now, therefore, be it resolved that a joint subcommittee to the Natural Gasoline Committee and the Refinery Committee shall be appointed to serve for 90 days from the date of this resolution,

Be it further resolved that said subcommittee shall investigate and secure information concerning the production of natural gasoline and the marketing thereof with the purpose of devising some means for the orderly and effective stabilization of markets for natural gasoline, gasoline, and other motor fuels, and to secure such additional outlets for natural gasoline as to encourage the reasonable and orderly entrance of this commodity in interstate commerce.

And be it further resolved, that the Planning and Coordination Committee immediately request the larger refiners of petroleum products to recognize the necessity of relieving the present situation with regard to natural gasoline, and to cooperate in every particular by purchasing, to the reasonable extent of their ability, surplus natural gasoline.

Until representation was given the natural-gasoline industry in administration of the oil code it was difficult for the industry to present its problems for consideration. The committee, in developing a program giving adequate consideration to natural-gasoline production in balancing the supply and demand of motor fuel, early recognized the need for improving natural-gasoline statistics on production and distribution. Accordingly a questionnaire has been adopted by the Bureau of Mines for obtaining the necessary information. It is recognized that the establishment of Committee J is potentially an important development; already much has been accomplished which will improve the position of the natural-gasoline industry.

PRICES AND MARKET CONDITIONS

Natural gasoline was the only refined product for which the average open-market price in 1934 was lower than in 1933. The average spot price of 26–70 grade natural gasoline in Oklahoma (group 3) was 2.6 cents per gallon in 1934 compared with 2.9 cents in 1933. Fluctuations in spot prices during 1934 were less pronounced than in 1933, when they ranged from an all-time low of 1 cent to a high of 5⅜ cents.

The 1934 high for 26–70 natural gasoline was 3¾ cents and the low 1¼ cents, with a few sales at 1 cent. In California, where nearly all of the natural gasoline is produced by the larger integrated companies, the output is correlated more closely with the refiners' demands, and therefore prices, as usual, were generally higher than in group 3.

Trade-journal quotations of 26–70 grade natural gasoline indicate that the usual downtrend of spot prices set in shortly after the first of the year. At the beginning of 1934 the 26–70 grade was quoted at 3⅜ cents per gallon (Oklahoma group 3), but with the tapering-off of heavy purchases by refiners for fall and winter gasoline stocks began to increase, with attendant recessions in prices, leaving a large part of the natural-gasoline production available to the jobber and coastwise trade. Although jobber business increased with the reduction in prices the volume taken by jobbers was small in proportion to production, and manufacturers turned to the export and coastwise markets to dispose of their surplus. The reduced prices stimulated buying for export and for coastwise shipment to the east coast, and large quantities were taken off the market.

In addition to the seasonal downtrend in demand for natural gasoline a number of depressing influences in the refinery-gasoline market affected natural-gasoline purchases. A Federal court decision that involved certain operators in the East Texas field—interpreted as being favorable to "hot-oil" producers—resulted in a weakened gasoline market in Oklahoma (group 3) and a slump in buying until conditions again became settled. The marked contraction in the buying of refinery gasoline had the inevitable effect of reducing purchases of all grades of natural gasoline. Small independent manufacturers who depend upon spot-market business for their output found their stocks accumulating and made price concessions to move them. As a result purchasers were reluctant to buy at a flat price, particularly for shipment over an extended period, and most sales were made on the "market date of shipment" basis.

By the end of March 1934, with refinery-gasoline storage nearly filled and refiners experiencing some difficulty in using normal amounts of natural gasoline, some manufacturers of the 26–70 grade turned their plants over to the production of lower vapor pressure grades, which were less difficult to move, while others sold blended products direct to the retail trade. The 26–70 grade was offered in Oklahoma and Texas at 1⅜ cents per gallon. As a result of manufacturing lower vapor pressure grades of natural gasoline supplies of the 26–70 grade were reduced and the price advanced to 2.5 cents. Manufacturers who had been storing part of their production, however, pushed these supplies into the open market, which was unable to stand the increased offerings, and prices again slumped.

At the beginning of June, manufacturers were becoming concerned over the steady increase in stocks. Lack of movement of refined gasoline directly influenced takings of natural gasoline, and the open market movement and contract business dropped off considerably. Toward the end of June stocks became so burdensome that manufacturers were forced to reduce prices drastically, and the 26–70 grade was quoted at 1¼ cents. In July, with the beginning of the active buying season of all grades of natural gasoline for blending purposes, prices advanced sharply, and by the end of the month the 26–70 grade was quoted at 3 cents per gallon in Oklahoma.

In the fall the trend of natural-gasoline output was definitely toward a higher vapor-pressure product. The greater part of the output was 26-, 22-, and 18-pound material that went directly to refineries for blending to increase volatility of motor fuels. Jobbers who were not equipped to handle the higher vapor-pressure product without loss commonly took 18-pound natural or even 14-pound for blending, and marketed 10- and 12-pound natural gasoline as straight motor fuel. With the advent of cooler weather conditions in the natural-gasoline market grew progressively better. By November it was almost impossible to obtain 26–70 grade for prompt shipment. Shipments to jobbers picked up considerably, and 11- and 12-pound stabilized natural gasoline suitable for motor fuel in the Northern States was available at 4.25 to 4.5 cents a gallon; 18-pound material suitable for blending sold for 3.5 to 3.75 cents. Toward the middle of December the market displayed a buoyant tendency, with demand exceeding supply, and prices advanced three-eighths to three-fourths cent per gallon.

CONSUMPTION

Although much of the improvement in the refinery demand for natural gasoline in 1934 can be credited to the trend toward the use of motor fuels having greater volatility, other factors may be cited as influencing the market. Many refiners use natural gasoline for blending when prices are low and curtail purchases only when increased prices make the practice unprofitable. It is quite possible, therefore, that the prevailing low price of natural gasoline throughout 1934 may have been responsible for some of the increase in refinery demand. In the late months of the year marked curtailment of gasoline output from east Texas, resulting from the enforcement of regulations by the Federal Tender Board that prevented interstate shipments of refined products not made from lawfully produced crude, also had a stimulating effect on consumption of natural gasoline. Gasoline manufactured from east Texas crude oil, even by straight-run operations, has an excess of volatility during some seasons of the year and in summer requires stabilization to meet motor-fuel specifications. Therefore, cessation of the east Texas flood of high-volatile gasoline requiring little or no natural gasoline bolstered the demand for motor fuel from refineries in other districts where larger admixtures of natural gasoline were necessary to give volatility to motor fuels. The inability of buyers to get straight-run material from east Texas also resulted in a noticeably increased demand for stabilized natural gasoline.

Another important factor that influenced consumption late in 1934 was the introduction by several major marketing companies of a new highly volatile motor fuel of aviation grade in which natural gasoline was used to obtain the desired volatility. The demand for cargo shipments of natural gasoline to the eastern seaboard was heavy, and large quantities also were shipped through the crude-oil lines of major companies or their pipe-line subsidiaries for delivery to refineries.

Blended at refineries by districts.—The increase in refinery blending of natural gasoline in motor fuel was fairly general throughout the country, as only three districts produced less than in 1933. (See preceding table.) Utilization of a high percentage of east Texas crude oil by Gulf coast refiners continues to cut natural-gasoline requirements for blending, and the Texas Gulf and Louisiana Gulf districts in 1934 reported decreases of 9.6 and 18.7 percent, respectively, from 1933. In the Rocky Mountain district the volume blended was 2 percent lower than in 1933.

The upward trend of purchases of natural gasoline by refiners in the East Coast district continued in 1934, and the amount used in blending increased 17.9 percent from 1933. Substantial increases in the volumes blended in the Appalachian, Indiana-Illinois-Kentucky, and Arkansas-Louisiana Inland districts reversed a downward trend in refinery blending in those districts which began several years ago.

More than 20 percent of the total output of gasoline in the United States is produced in the East Coast and Appalachian districts, and even a small increase in motor-fuel volatility requirements in the Eastern States creates a sharp demand for natural gasoline which is supplied principally from the Mid-Continent. With 387,324,000 gallons of natural gasoline utilized by refiners in motor-fuel blends, a gain of 8.1 percent above 1933, California again was by far the greatest consumer of natural gasoline. Reflecting increased utilization of natural gasoline for blending at refineries the percentage of natural gasoline in refinery-gasoline output throughout the country rose from 6.3 in 1933 to 6.8 in 1934. The following table shows the percentage of natural gasoline used in refinery gasoline in the different districts.

Percentage of natural gasoline blended in refinery gasoline, 1933–34, by districts

Year	East Coast	Appalachian	Illinois, Indiana, Kentucky	Oklahoma, Kansas, Missouri	Texas Inland	Texas Gulf coast	Louisiana Gulf coast	Arkansas and Louisiana Inland	Rocky Mountain	California	Total
1932	0.9	2.2	3.0	9.4	11.5	4.8	5.3	9.6	12.4	14.5	6.7
1933	1.6	1.4	2.8	9.0	11.0	3.5	2.0	4.8	10.1	15.6	6.3
1934	1.9	2.3	4.8	10.5	12.2	2.9	1.6	6.0	9.0	16.2	6.8

Trend of stocks.—At the beginning of the year a new basis for reporting stocks of natural gasoline was inaugurated, making it necessary to adjust 1933 year-end inventories at plants and at refineries in California so that the figures would be comparable with the monthly reports of stocks in 1934. Calculated upon the new basis total stocks at natural-gasoline plants on January 1 were 41,664,000 gallons. During the spring period of curtailed purchases and increased production, inventories at plants rose sharply, reaching a record high of 69,129,000 gallons in June. With the approach of the refinery buying season in July stocks at plants began decreasing and continued downward to the year's low of 36,100,000 gallons on December 31. Stocks held by refineries rose from 112,896,000 gallons at the beginning of 1934 to 137,130,000 in September and receded to 120,960,000 gallons at the close of the year. Total reserves in the hands of refiners and natural-gasoline plant manufacturers stood at 157,060,000 gallons on December 31, 1934, or 2,500,000 gallons more than the supply in storage at the beginning of the year.

Exports.—Because natural gasoline is mixed with crude oil in many export consignments, whereby it loses its identity, complete data on cargo movements of natural gasoline are not available. However, upon the basis of shipments from the several customs districts as reported by the Bureau of Foreign and Domestic Commerce and of shipments from California as reported direct to the Bureau of Mines by the exporting companies, 68,159,700 gallons of natural gasoline were exported during 1934. Shipments of various grades of stabilized natural gasoline from Gulf coast ports to the Atlantic seaboard, Canada, and Europe amounted to 39,050,046 gallons or about 57 percent of the total cargo shipments.

An unusually large drop in exports from California as a result of complete stoppage of consignments to foreign countries bordering the Atlantic reduced shipments 64 percent—from 45,591,672 gallons in 1933 to 16,251,312 in 1934. Total exports of 16,251,312 gallons to Pacific foreign markets were 38 percent higher than the comparable quantity of 11,794,776 gallons in 1933. A large part of the 1934 shipments was consigned to Canada.

Sales to jobbers.—Accurate statistics on the amount of natural gasoline sold to jobbers are not available, but based on a combined volume of 197,946,000 gallons exported and sold to jobbers, of which 68,159,700 gallons were exported, total sales to jobbers of 129,786,300 gallons in 1934 are indicated. Comparable figures for 1933 are not available.

PRODUCTION BY STATES AND FIELDS

Texas.—Texas produced 463,400,000 gallons of natural gasoline in 1934 and made the largest gain in output, an increase of 26 percent over 1933. This increase was due principally to activity in the Panhandle area, where the production (256,400,000 gallons) was 40 percent more than the output in 1933. Although most of the gas produced in the Panhandle is "dry" and contains only a fraction of a gallon of natural gasoline per thousand cubic feet, a considerable part of the production is processed by utility companies to remove the wet fractions and thereby render the gas suitable for pipe-line transmission. Most of the gas, however, is treated solely for its natural-gasoline content, and the residue gas is blown to the air. In 1934 the quantity of gas treated in plants in the Panhandle area was approximately 644,000,000,000 cubic feet. Based on the total extraction of 256,400,000 gallons of natural gasoline an average recovery of about 0.4 gallon per thousand cubic feet is indicated.

By the very nature of conditions under the Panhandle sour-gas or "stripping" law many companies now operating natural-gasoline plants in the Panhandle have to make the best of a bad situation. These companies as a rule do not condone the waste that results from treating unlimited quantities of gas without regard to utilizing the residue but are forced to engage in these operations as a means of utilizing the gas from their properties before it becomes depleted as a result of neighboring operations. With gasoline recovery less than one-half gallon per thousand cubic feet and prevailing low prices the reserve is being dissipated rapidly with but little revenue to the producer and landowner. Several companies report appreciable reductions in the amount of gas coming to their plants compared with 6 months ago, and it is true also that new connections are being made each month by some plants to maintain their production.

With an output of 46,400,000 gallons in 1934 compared with 20,200,000 gallons in 1933 the East Texas field gained 130 percent in natural-gasoline production, the largest increase of any field in the United States. Although production is still small compared with other larger fields in the country the East Texas field continues to become increasingly important as a source of natural gasoline, and a substantial increase in production may be expected in succeeding years. The mounting production is partly accounted for by the increasing number of wells that are being connected to plant-gathering systems and partly by the fact that richer gas is coming into plants. In some instances the richer gas has resulted from maintaining a partial vacuum on the gathering lines.

Because of the small amount of gas produced with the oil in the East Texas field and because much of the acreage is held in small blocks conditions have not altogether favored the construction of natural-gasoline plants. As a result, the output of natural gasoline has lagged behind the growth of the field and the potential amount of natural gasoline which could have been manufactured under more favorable conditions. Although the first well in the East Texas field was completed in October 1930 the first natural-gasoline plant was not built until more than a year later, after more than 3,300 wells had been completed. A recent survey shows that less than half the wells are connected to gasoline plants. However, with the present trend toward processing more of the gas produced in the field a greater percentage of wells will be connected to plant gathering systems, and a material increase in natural-gasoline operations may be expected.

Production in the North Texas area dropped 20 percent to 20,500,000 gallons in 1934, while the West Central fields with an output of 84,600,000 gallons gained nearly 9 percent.

Texas gradually is becoming the leading State in natural-gasoline production, a position California has held for many years. Largely as the result of the steady increase in production in the Panhandle the margin between the output in California and Texas has been decreased until in November and December 1934 Texas produced more natural gasoline than any other State.

California.—Large increases in natural-gasoline production in some fields in California were offset by decreases in other fields. The total production in 1934 was 498,200,000 gallons, only slightly more than the 1933 output of 496,300,000 gallons. California continued to lead all States in total natural-gasoline production in 1934, although Texas forged ahead in the last 2 months of the year.

The Kettleman Hills field, with 153,000,000 gallons of natural gasoline in 1934 compared with 133,500,000 gallons in 1933, increased its production nearly 15 percent. In the old Huntington Beach field, where directional drilling has been adopted to reach the productive horizons beyond the shore line, natural-gasoline production continued to reflect the increased supplies of natural gas made available by this development. Increases of over 50 percent in production have been reported in both 1933 and 1934 compared with previous years. The output in 1934 was 39,000,000 gallons. Compared with 1933, production in the Santa Fe Springs field in 1934 declined 24 percent to 61,000,000 gallons, and there was a corresponding drop of nearly 15 percent to 75,500,000 gallons in the Long Beach field. A diminishing supply of available gas is to be expected from these fields because of their age.

Production of natural gasoline in the Ventura Avenue field in 1934 totaled 43,700,000 gallons, 2.9 percent less than in 1933.

Oklahoma.—Conditions somewhat comparable with those in California prevailed in Oklahoma, where some regional increases in output were offset by declines in other districts. Production of natural gasoline in 1934 was 356,500,000 gallons, 1 percent less than in 1933. Increases of 7.3 and 9.2 percent were reported in the Oklahoma City and Osage fields, but a sharp decline of 24.2 percent was reported in the Seminole area. Production of the Oklahoma City field increased from 96,500,000 gallons in 1933 to 103,500,000 gallons in 1934, as a result of the construction of recycling plants for gas-lift operations. The gain in output in the Osage district to 44,900,000 gallons in 1934 reflects increased gas production in that area due to the development of a new deep sand.

West Virginia.—West Virginia has the largest natural-gasoline output in the Appalachian district. Production in 1934 is estimated at 37,800,000 gallons, about 5 percent lower than in 1933.

Pennsylvania.—Pennsylvania produced approximately 11,100,000 gallons of natural gasoline in 1934, 5 percent less than in 1933.

New Mexico.—Reflecting the additional supplies of gas made available as a result of new discoveries in New Mexico during the year, natural-gasoline production in 1934 increased to 21,900,000 gallons, 14.4 percent more than in 1933.

Wyoming.—After several years of declining production the downtrend was reversed in 1934, and Wyoming produced approximately 34,900,000 gallons, a moderate increase—2.3 percent—over 1933.

LIQUEFIED PETROLEUM GASES [2]

The marketed production of liquefied petroleum gases—propane, butane, pentane, and propane-butane mixtures—totaled 48,173,000 gallons in 1934, a gain of 9,242,000 gallons (23.7 percent) over the 38,931,008 gallons reported for 1933. The 1934 deliveries were divided as follows: Domestic consumption, 17,681,000 gallons; gas manufacturing, 6,290,000 gallons; and industrial and miscellaneous uses, 24,202,000 gallons. Detailed statistics of production in 1933 and 1934 by kinds and uses are summarized in the following table:

Marketed production of liquefied petroleum gases in the United States, 1933–34, by kinds and uses, in gallons

Kind and use	1933	1934	Percent of change in 1934
Propane:			
Domestic	14, 334, 412	15, 236, 000	+6. 3
Gas manufacture	199, 534	326, 000	+63. 4
Industrial and miscellaneous	1, 300, 784	3, 119, 000	+139. 8
	15, 834, 730	18, 681, 000	+18. 0
Butane:			
Domestic	705, 894	1, 046, 000	+48. 2
Gas manufacture	6, 170, 570	5, 064, 000	−17. 9
Industrial and miscellaneous	12, 179, 766	19, 443, 000	+59. 6
	19, 056, 230	25, 553, 000	+34. 1
Pentane and propane-butane mixtures:			
Domestic	1, 585, 282	1, 399, 000	−11. 8
Gas manufacture	1, 948, 221	900, 000	−53. 8
Industrial and miscellaneous	506, 545	1, 640, 000	+223. 8
	4, 040, 048	3, 939, 000	−2. 5
Grand total	38, 931, 008	48, 173, 000	+23. 7

[2] Statistics compiled by A. T. Coumbe, Jr., Petroleum Economics Division.

Propane is used largely for domestic purposes in households beyond the reach of gas-company mains, but new uses constantly are being found for this gas by the manufacturing industries, particularly those requiring close control of heat. Petroleum refiners use propane as a solvent in the manufacture of lubricating oils and as a refrigerant in dewaxing. Butane, which is employed principally for industrial purposes, also serves as an enriching agent in gas manufacture. Recent experiments on the Pacific coast indicate that propane-butane mixtures make a very satisfactory motor fuel for internal-combustion engines. So far this use for automotive vehicles has been confined largely to heavy-duty trucks and busses, which run between fixed terminals, where supply points for these gases have been established.

The American Gas Association has cooperated with the Bureau of Mines in this review of liquefied petroleum gases in 1934 by furnishing the following information regarding their distribution:

> Liquefied petroleum gas continued to gain favor among the small communities throughout the country during 1934. Three new companies began operations, bringing the total up to 72. These 72 companies supplied gas to approximately 30,000 customers in 171 communities in 28 States. Butane-air-gas with a heating value ranging from 520 to 600 B. t. u. per cubic foot was supplied to 110 communities in 26 States by 59 companies.
>
> Undiluted butane and propane gas with a heating value of 2,800 to 3,000 B. t. u. per cubic foot was supplied to 14 communities in California and Nevada by 6 companies. Seven companies in Maryland, Minnesota, New Jersey, North Dakota, Virginia, and Wisconsin supplied 47 communities with undiluted propane gas with a heating value of 2,550 B. t. u. per cubic foot.
>
> Although no new communities in Canada were added during the year, persons living within a 30-mile radius of Calais, Maine, were given an opportunity to receive gas service by the formation of the Citizens Philgas Co. Milltown and St. Stephen, New Brunswick, continued to be supplied from Calais, Maine, while the plant at Three Rivers, Quebec, continued to supply that town.

Most of the gain in demand for liquefied petroleum gases has been in the industrial field, where bulk shipments comprise the usual method of handling; consequently the quantity moving into consumption by tank car, tank truck, and pipe lines increased to 32,794,000 gallons, or 68.1 percent of all shipments in 1934, compared with 24,515,445 gallons, or 63.0 percent of the total deliveries in 1933. Cylinder and drum shipments in 1934 were 15,379,000 gallons, which, although higher than the 1933 total, represented only 31.9 percent of all shipments compared with 37.0 percent in 1933.

Deliveries on the Pacific coast were 11,471,000 gallons, a gain of 70.8 percent over 1933. The sharp rise in the demand in this area is largely the result of the increased use of these gases as fuel for internal-combustion engines. Deliveries east of the Rockies were 36,702,000 gallons in 1934, a gain of 13.9 percent over 1933.

CARBON BLACK

By G. R. Hopkins and H. Backus

SUMMARY OUTLINE

The carbon-black industry, which had established a new record for sales in 1933, made marked progress in 1934. Although the indicated plant demand in 1934 was considerably below the record total of 1933,

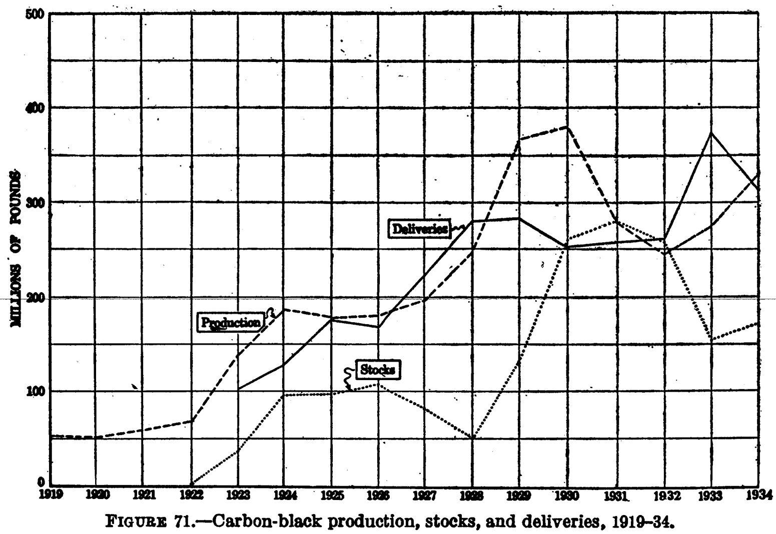

Figure 71.—Carbon-black production, stocks, and deliveries, 1919–34.

prices were approximately 30 percent higher and probably more than offset increased costs of operation under the code approved February 8, 1934. Production of carbon black in 1934 was 328,828,000 pounds, or 20 percent more than the output in 1933 (see fig. 71). Stocks at the plants, which had declined materially in 1933 due largely to speculative buying, increased approximately 16,000,000 pounds in 1934; the total on hand December 31, 1934, was 171,799,000 pounds or about a 6 months' supply.

Salient statistics of carbon black made from natural gas in the United States, 1924, 1928, and 1932–34

	1924	1928	1932	1933	1934
Number of producers reporting	46	31	24	[1] 25	25
Number of plants	69	65	50	[1] 51	50
Quantity produced:					
By States and districts:					
Louisiana pounds	144,601,550	136,320,000	42,260,000	54,470,000	66,538,000
Texas:					
Breckenridge do	13,764,014	35,901,000	[2] 23,071,000	[2] 24,499,000	[2] 24,887,000
Panhandle do		64,927,000	177,369,000	[1] 194,156,000	237,403,000
Total Texas do	13,764,014	100,828,000	[2] 200,440,000	[1,2] 218,655,000	[2] 262,290,000
Other States do	28,506,470	11,642,000	(2)	(2)	(2)
Total United States do	186,872,034	248,790,000	242,700,000	[1] 273,125,000	328,828,000
By processes:					
Channel process do	162,257,725	220,532,000	224,536,000	[1] 238,026,000	293,546,000
Other processes [3] do	24,614,309	28,258,000	18,164,000	35,099,000	35,282,000
Stocks held by producers Dec. 31 pounds	95,671,246	50,240,000	257,998,000	[1] 155,969,000	171,799,000
Losses do	660,836	802,000	4,814,000	686,000	386,000
Quantity sold:					
Domestic:					
To rubber companies do	(4)	140,938,000	130,380,000	191,358,000	165,446,000
To ink companies do	(4)	27,223,000	18,341,000	18,539,000	16,146,000
To paint companies do	(4)	20,040,000	7,636,000	6,260,000	5,365,000
For miscellaneous purposes do	(4)	14,475,000	5,126,000	[1] 6,025,000	5,035,000
Total domestic sold do	(4)	202,676,000	161,483,000	[1] 222,182,000	191,992,000
Export do	(5)	77,903,000	100,072,000	152,286,000	120,620,000
Total sold do	128,860,766	280,579,000	261,555,000	[1] 374,468,000	312,612,000
Value (at plants) of carbon black produced:					
Total	$11,564,936	$13,782,000	$6,664,000	[1] $7,602,000	$11,654,000
Average per pound cents	6.19	5.54	2.75	[1] 2.78	3.54
Estimated quantity of natural gas used M cubic feet	156,514,000	175,137,000	168,237,000	[1] 190,081,000	229,933,000
Average yield per M cubic feet pounds	1.19	1.42	1.44	1.44	1.43

[1] Revised figures.
[2] Oklahoma and Wyoming included with Breckenridge district, Texas.
[3] 1924: Chain, disk, roller, "special", and thermatomic; 1928 and 1932–33: Disk, Lewis, roller, "special", and thermatomic; 1934: Lewis, roller, "special", and thermatomic.
[4] Figures not available.
[5] Exports not separately recorded by Bureau of Foreign and Domestic Commerce prior to 1925.

PRODUCTION

Production by States, districts, and months.—In 1934 the center of carbon-black production remained virtually stationary, as production in Louisiana showed approximately the same proportionate increase as that in the Panhandle.

The output of carbon black in the Texas Panhandle totaled 237,403,000 pounds in 1934, an increase of 22 percent over 1933; it amounted to 72 percent of the total output of the United States in 1934 compared with 71 percent in 1933. As the producers in Oklahoma and Wyoming do not desire to have their output revealed, it has been combined with that of the Breckenridge district of Texas; hence it is not possible to show the trend of output in each of these three areas. However, their total production in 1934 was only slightly above that in 1933.

Carbon black produced from natural gas in the United States, 1933–34, by States and by major producing districts

State and district	Producers reporting	Number of plants	Production: Pounds	Production: Value at plant: Total	Production: Value at plant: Average (cents)	Quantity of natural gas used (M cubic feet)	Average yield per M cubic feet (pounds)
1933							
Louisiana: Monroe-Richland district (Morehouse, Ouachita, and Richland Parishes)	11	19	54,470,000	$1,565,000	2.87	40,865,000	1.33
Oklahoma	1	1	(1)	(1)	(1)	(1)	(1)
Texas:							
Breckenridge district (Eastland and Stephens Counties)	4	5	[1] 24,499,000	[1] 688,000	[1] 2.81	[1] 13,186,000	[1] 1.86
Panhandle district (Carson, Gray, Hutchinson, and Wheeler Counties) [2]	14	25	194,156,000	5,349,000	2.76	136,030,000	1.43
Total Texas [2]	[3] 15	30	[1] 218,655,000	[1] 6,037,000	[1] 2.76	[1] 149,216,000	[1] 1.47
Wyoming	1	1	(1)	(1)	(1)	(1)	(1)
Total United States [2]	[3] 25	51	273,125,000	7,602,000	2.78	190,081,000	1.44
1934							
Louisiana: Monroe-Richland district (Morehouse, Ouachita, and Richland Parishes)	11	18	66,538,000	2,345,000	3.52	53,764,000	1.24
Oklahoma	1	1	(1)	(1)	(1)	(1)	(1)
Texas:							
Breckenridge district (Eastland and Stephens Counties)	4	5	[1] 24,887,000	[1] 1,005,000	[1] 4.04	[1] 13,241,000	[1] 1.88
Panhandle district (Carson, Gray, Hutchinson, and Wheeler Counties)	14	25	237,403,000	8,304,000	3.50	162,928,000	1.46
Total Texas	[3] 15	30	[1] 262,290,000	[1] 9,309,000	[1] 3.55	[1] 176,169,000	[1] 1.49
Wyoming	1	1	(1)	(1)	(1)	(1)	(1)
Total United States	[3] 25	50	328,828,000	11,654,000	3.54	229,933,000	1.43

[1] Oklahoma and Wyoming included with Breckenridge district, Texas.
[2] Revised figures.
[3] In counting the total number of producers, a producer operating in more than 1 State, district, or county is counted only once.

The National Gas Products Association compiles monthly data covering production of carbon black. Although these data are only about 90 percent complete, they provide a basis for analyzing the trend of daily average production by months. In 1934 this trend was remarkably uniform; the lowest daily average (850,700 pounds for January) was less than 9 percent below the highest (930,300 pounds for August).

Monthly carbon-black production in the United States in 1934, in pounds

Month	National Gas Products Association	Bureau of Mines[1]	
		Total	Daily average
January	24,050,000	26,372,000	850,700
February	22,732,000	24,925,000	890,200
March	25,415,000	27,852,000	898,500
April	24,847,000	27,227,000	907,600
May	25,563,000	28,016,000	903,700
June	24,240,000	26,569,000	885,600
July	25,516,000	27,983,000	902,700
August	26,327,000	28,838,000	930,300
September	25,038,000	27,457,000	915,200
October	25,986,000	28,477,000	918,600
November	24,575,000	26,931,000	897,700
December	25,720,000	28,181,000	909,100
	300,009,000	328,828,000	900,900

[1] Monthly figures obtained by allocating the Bureau's annual total proportionately to the Association's monthly data.

Methods and yields.—Carbon black is produced by two principal methods—impingement of a natural-gas flame on a comparatively cold surface and incomplete consumption of natural gas in a chamber. The "cold" surface generally used is channel iron, and channel black is the most common type of carbon black. Data of production by the channel process are given separately, but production by all other methods is combined to avoid disclosing the extent of individual operations. In general, channel black is superior to retort black in quality but the yield usually is lower. Channel black represented 89 percent of the total production in 1934 compared with 87 percent in 1933. This increase in the relative importance of channel black indicates increased demand for this product by the rubber industry.

The average yield of carbon black declined from 1.44 pounds per thousand cubic feet of gas burned in 1933 to 1.43 pounds in 1934, probably due to the gain in relative importance of channel black. The average yield has changed little in recent years, as few improvements have been made in production technique.

The carbon-black industry is an important consumer of natural gas; it utilized 229,933,000,000 cubic feet in 1934 compared with 190,081,000,000 cubic feet in 1933.

In the Carbon Black chapter of Minerals Yearbook, 1934, mention was made of the development of "dustless" carbon black in the shape of small pellets for transportation in bulk. Information from the trade indicates that production of this type of carbon black increased materially in 1934.

Number and capacity of plants.—The stabilizing effect of the Carbon Black Code and the fact that only the most efficient plants survived the price declines of 1930 and 1931 tended to maintain the status quo of the producing units of the industry in 1934. There were 50 plants operating in 1932, 51 in 1933, and 50 in 1934; furthermore, the list of operating companies showed little change during the 3 years. In general, economic conditions in the carbon-black industry in recent years have been such as to permit established companies to operate but to discourage the entrance of newcomers.

The total daily capacity of the plants operated in 1934 was 1,315,975 pounds, or 26,150 pounds more than the capacity of those operated in 1933. As the average daily production of carbon black in 1934 was 900,000 pounds the plants operated at 68 percent of their capacity during the year, compared with 58 percent in 1933.

Number and daily capacity of carbon-black plants operated in the United States, 1933–34, by counties or parishes

State	County or parish	Number of plants		Total daily capacity (pounds)	
		1933	1934	1933	1934
Louisiana	Morehouse	5	5	69,350	74,850
	Ouachita	12	12	224,775	234,275
	Richland	2	1	20,000	14,000
		19	18	314,125	323,125
Oklahoma	Beckham	1	1	(1)	(1)
Texas	Carson	2	2	[2] 111,000	[2] 111,000
	Eastland	1	1	(1)	(1)
	Gray	9	9	321,400	333,400
	Hutchinson	[3] 11	11	[3] 438,750	441,750
	Stephens	4	4	[1] 104,550	[1] 106,700
	Wheeler	3	3	(2)	(2)
		[3] 30	30	[1] [3] 975,700	[1] 992,850
Wyoming	Niobrara	1	1	(1)	(1)
United States		[3] 51	50	[3] 1,289,825	1,315,975

[1] Oklahoma, Wyoming, and Eastland County, Tex., included with Stephens County, Tex.
[2] Wheeler County included with Carson County.
[3] Revised figures.

Producers.—The list of carbon-black producers in 1934 remained virtually unchanged from 1933. The plant of the Century Carbon Co. at Mangham, La., a producer in 1933, was not operated in 1934, and the United Carbon Co. revised its report as to the location of 2 of the 4 plants operated by the Eastern Carbon Black Co. in the Texas Panhandle.

Carbon-black producers of the United States, as of Dec. 31, 1934

State and company	County	Nearest town	Process
Louisiana:			
Century Carbon Co., 251 Front Street, New York, N. Y.	Ouachita	Swartz	Channel.
	Richland	Archibald	Do.
J. Smylie Herkness, Route 2, Bastrop, La.	Morehouse	Bastrop	Do.
J. M. Huber Co. of Louisiana, Inc., 460 West 34th Street, New York, N. Y.	Ouachita	Swartz	Do.
Imperial Oil & Gas Products Co., 1104 Union Bank Building, Pittsburgh, Pa.	do	Sterlington	Do.
Keystone Carbon Co., Inc., P. O. Box 11, Monroe, La.	do	Monroe	Do.
Monroe-Louisiana Carbon Co., 45 East 42d Street, New York, N. Y.	do	Hancock	Lewis.
Peerless Carbon Black Co., 3003 Grant Building, Pittsburgh, Pa.	do	Bourland	"Special."
Southern Carbon Co., 45 East 42d Street, New York, N. Y.	Morehouse	Perryville	Channel.
	Ouachita	Fowler	Do.
	do	Swartz	Do.
Texas-Louisiana Producing & Carbon Co., P. O. Box 181, Monroe, La.	Morehouse	Colliston	Do.
Thermatomic Carbon Co., 230 Park Avenue, New York, N. Y.	Ouachita	Sterlington	Thermatomic.
United Carbon Co., P. O. Box 1475, Charleston, W. Va.	Morehouse	Bastrop	Channel.
	do	Dewdrop	Do.
	Ouachita	Guthrie	Do.
	do	Phillips	Do.
	do	Swartz	Do.
Oklahoma: Oklahoma Carbon Industries, Inc., Sayre, Okla.	Beckham	Sayre	Do.
Texas:			
Cabot Carbon Co., 940 Old South Building, Boston, Mass.	Gray	Pampa	Do.
Cabot Co., 940 Old South Building, Boston, Mass.	Carson	Skellytown	Channel and roller.

Carbon-black producers of the United States, as of Dec. 31, 1934—Continued

State and company	County	Nearest town	Process
Texas—Continued.			
Coltexo Corporation, 45 East 42d Street, New York, N. Y.	Gray	Lefors	Channel.
	Stephens	Parks	Do.
Crecent Carbon Co., Point Pleasant, W. Va.	Hutchinson	Borger	Do.
Eastern Carbon Black Co. (United Carbon Co., owner), P. O. Box 1475, Charleston, W. Va.	do	Borger (2 plants)	Do.
	do	Sanford	Do.
	do	Stinnett	Do.
General Atlas Chemical Co., 60 Wall Street, New York, N. Y.	Gray	Pampa	"Special."
J. M. Huber Co. of Louisiana, Inc., 460 West 34th Street, New York, N. Y.	Carson	Skellytown	Channel.
	Hutchinson	Borger	Do.
Kosmos Carbon Co. (United Carbon Co., owner), P. O. Box 1475, Charleston, W. Va.	do	Borger (2 plants)	Do.
Magnolia Petroleum Co., Dallas, Tex	Gray	Pampa	Do.
	Wheeler	Magic City	Do.
Palmer Carbon Co., 80 East Jackson Boulevard, Chicago, Ill.	Hutchinson	Borger	Do.
Panhandle Carbon Co., 251 Front Street, New York, N. Y.	do	do	Do.
Peerless Carbon Black Co., 3003 Grant Building, Pittsburgh, Pa.	Eastland	Pioneer	"Special."
	Gray	Pampa	Do.
Texas Carbon Industries, Inc., Sayre, Okla	Stephens	Breckenridge (2 plants).	Channel.
Texas Elf Carbon Co., 940 Old South Building, Boston, Mass.	Gray	Pampa	Do.
	Stephens	Eliasville	Do.
Western Carbon Co., 45 East 42d Street, New York, N. Y.	Gray	Kings Mill	Do.
	do	Lefors	Do.
	do	Pampa	Do.
	Hutchinson	Borger	Do.
	Wheeler	Lela	Do.
	do	Magic City	Do.
Wyoming: J. M. Huber Co. of Louisiana, Inc., 460 West 34th Street, New York, N. Y.	Niobrara	Manville	Do.

DEMAND

Domestic consumption.—Sales of carbon black by manufacturers declined from 374,468,000 pounds in 1933 to 312,612,000 pounds in 1934. These sales represent total deliveries from the plants to brokers and consumers. In normal times such deliveries approximate actual consumption but in 1933, because of speculative buying, they were probably considerably in excess of actual consumption. Of the total sales, 120,620,000 pounds (39 percent) were exported in 1934 compared with 41 percent in 1933. Of the domestic deliveries in 1934, 165,446,000 pounds (86 percent) were consigned to rubber companies, 16,146,000 pounds (8 percent) to ink companies, 5,365,000 pounds (3 percent) to paint and varnish companies, and 5,035,000 pounds (3 percent) to companies producing miscellaneous products (see fig. 72). These data do not indicate any material change in relative importance of the four classes of domestic consumption.

As the rubber industry utilizes over 80 percent of the total carbon black produced, a brief review of rubber consumption in 1934 is appropriate. According to E. G. Holt of the Bureau of Foreign and Domestic Commerce, the total consumption of rubber in the United States in 1934 was 554,000 long tons, of which 100,800 tons was reclaimed rubber. These figures indicate a gain of 14 percent in total consumption compared with 1933 but no material change in ratio of reclaimed rubber to crude rubber. Production of automobile casings, which accounts for at least 60 percent of the total consumption of rubber in the United States, again increased, although the gain was not as pronounced as that in motor-vehicle production. According to estimates based on figures of the Rubber Manufacturers' Association 47,300,000 casings were produced in 1934, compared with

45,375,552 reported by the Bureau of the Census for 1933. As the total consumption of rubber in the United States in 1934 showed a much sharper increase than production of casings the trend toward larger tires with thicker treads evidently was continued.

According to Holt the total "absorption" of or demand for crude rubber in the world in 1934 was 942,000 long tons, of which slightly more than half was consumed outside the United States. The consumption of crude rubber in foreign countries has increased materially in recent years; this expansion has been detrimental to the rubber industry in the United States but has been a boon to the American carbon-black manufacturers who supply nearly all the world's requirements of channel black.

Sales of carbon black to ink companies declined in 1934 although, according to data supplied by B. M. Frost of the Bureau of Foreign and Domestic Commerce, the consumption of newsprint in the United

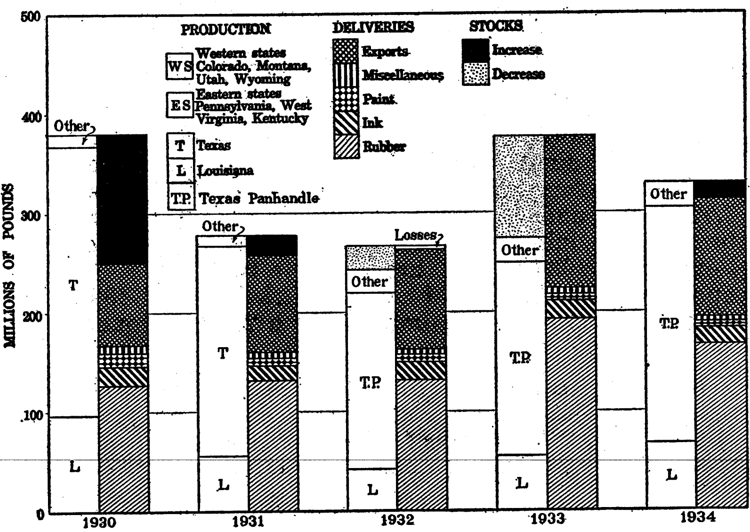

FIGURE 72.—Production and consumption of carbon black, 1930–34.

States was substantially higher in 1934 than in 1933. This anomaly apparently was due to speculative buying of carbon black late in 1933, as previously noted. The preliminary figure shows newsprint production in the United States in 1934 was 957,200 short tons compared with 928,300 tons in 1933; imports were 2,209,700 short tons in 1934 compared with 1,793,541 tons in 1933.

Sales of carbon black to paint companies declined from 6,260,000 pounds in 1933 to 5,365,000 pounds in 1934. Final statistics of paint production in 1934 are not available, but it probably increased over 1933. In that event the decrease in sales of carbon black to paint companies must have been due to speculative buying in 1933 or to a decrease in the use of black paint on motor vehicles.

Sales of carbon black for so-called "miscellaneous purposes", such as the manufacture of carbon paper, polish, artificial stone, fertilizer, and typewriter ribbons, totaled 5,035,000 pounds in 1934 or about a million pounds less than in 1933. No data are available to indicate why these industries apparently used less carbon black in 1934; however, they probably drew on stocks for part of their requirements.

Losses of carbon black, reported by manufacturers, totaled only 386,000 pounds in 1934 compared with 686,000 pounds in 1933. These data probably represent losses from handling for production losses, such as those represented by the smoke clouds seen around most plants, are eliminated automatically by calculating production as sales plus or minus changes in stocks.

Exports.[1]—Exports of carbon black in 1934 totaled 120,620,219 pounds, a decrease of 21 percent from 1933; the total value was $5,541,143 or virtually the same as in 1933, indicating that the loss in volume was compensated by an increase in average price. The average value of exports was 4.59 cents per pound in 1934 0.94 cent higher than in 1933 and 1.05 cents above the average price f. o. b. producers' plants in 1934.

The United Kingdom, with purchases of 37,696,893 pounds of carbon black from the United States in 1934, continued to be the leading customer; France continued second, Germany third, and Canada fourth. Exports to Australia increased from 5,121,578 pounds in 1933 to 7,821,796 pounds in 1934, and this increase was the outstanding exception to the general decline in exports. December was again the leading month in carbon-black exports; monthly exports in 1934 ranged from a low of 5,262,004 pounds in February to a high of 17,928,008 pounds in December. Galveston and New Orleans are the principal shipping points for carbon black, and 81 percent of the total exports in 1934 passed through these two ports.

Imports of "gas black and carbon black" totaled 489,668 pounds valued at $49,893 in 1934, compared with 212,950 pounds valued at $19,845 in 1933.

Carbon black exported from the United States, 1932–34, by countries

Country	1932		1933		1934	
	Pounds	Value	Pounds	Value	Pounds	Value
Argentina	1,540,984	$75,009	1,659,484	$69,480	1,602,208	$79,294
Australia	4,052,346	184,713	5,121,578	182,745	7,821,796	398,230
Belgium	3,351,515	156,027	5,376,058	192,064	3,451,426	164,166
Canada	6,977,194	224,254	10,578,559	303,115	11,669,472	517,247
China	1,328,446	63,114	2,033,162	75,677	1,052,287	55,835
France	19,459,854	895,177	32,417,013	1,191,920	22,725,781	1,016,457
Germany	16,216,415	695,446	20,327,467	745,052	16,499,442	706,348
Italy	3,391,780	151,893	7,196,800	259,313	4,475,344	220,830
Japan	5,997,461	278,464	9,335,065	377,497	3,464,300	155,445
Netherlands	2,424,612	108,426	6,690,947	238,119	1,929,661	85,144
Spain	852,463	37,986	1,719,323	59,649	1,206,495	61,879
United Kingdom	31,059,005	1,392,895	42,603,940	1,589,503	37,696,893	1,694,220
Other	3,420,411	172,927	7,226,782	268,011	7,025,114	386,048
	100,072,486	4,436,331	152,286,178	5,552,145	120,620,219	5,541,143

[1] Figures on exports compiled by A. H. Redfield, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Carbon black exported from the United States in 1934, by months and districts

Month	Pounds	Value	District	Pounds	Value
January	10,284,512	$402,470	Galveston	60,186,447	$2,702,150
February	5,262,004	233,161	New Orleans	37,483,099	1,755,962
March	5,835,782	284,809	Michigan	11,263,421	494,939
April	8,059,978	373,228	Los Angeles	5,715,369	285,632
May	8,513,856	391,415	Sabine	3,700,604	158,027
June	16,148,802	733,990	San Francisco	1,160,010	58,399
July	11,689,229	560,214	New York	658,592	60,352
August	9,489,739	443,048	Buffalo	171,247	12,200
September	8,804,411	409,179	Vermont	103,654	3,002
October	6,711,632	334,028	St. Lawrence	79,695	3,812
November	11,892,266	537,064	Philadelphia	49,720	3,515
December	17,928,008	838,537	Other	48,361	3,153
	120,620,219	5,541,143		120,620,219	5,541,143

STOCKS

Stocks of carbon black at the plants, which had been reduced drastically during 1933, increased from 155,969,000 pounds on January 1, 1934, to 171,799,000 pounds on December 31, 1934. This increase was not entirely unexpected as it was generally recognized that much of the demand in the latter part of 1933 was occasioned by the desire to build up consumers' and brokers' inventories before the increased prices went into effect. Stocks at the plants on December 31, 1934, represented about a 6 months' supply compared with about a 5 months' supply on hand at the beginning of the year.

PRICES AND VALUES

A new series of posted carbon-black prices became effective January 1, 1934; in general, all prices were raised as a reflection of improved economic conditions and in anticipation of increased costs under the code. Most carbon-black sales are made on contract instead of at posted prices, and the sentiment for increased prices at the close of 1933 was reflected in higher quotations in the contracts. Accordingly, the average value of carbon black at the plants advanced from 2.78 cents a pound in 1933 to 3.54 cents in 1934. The total value increased from $7,602,000 in 1933 to $11,654,000 in 1934.

The new prices of January 1, 1934, were on the basis of seven zones, designated by the letters A to G. In general, prices are highest in zones farthest from centers of production, due to higher freight costs. As prices prior to January 1, 1934, were on an f. o. b. basis rather than c. i. f. and were not by zones, no direct comparison can be made between the data for 1933 and 1934. However, the price advance of January 1, 1934, probably was close to 1 cent a pound. Posted prices remained virtually unchanged throughout 1934, trade reports indicating a tendency toward higher prices as demand from the rubber industry continued to surpass expectations.

Quoted prices of various grades of carbon black in 1934, in cents per pound

[Oil, Paint and Drug Reporter]

Date	Standard rubber, ink, and paint qualities (car lots)							Special grades for varnishes, lacquers, and enamels (cases delivered)						
	Zone [1]							Grade						
	A	B	C	D	E	F	G	1	2	3	4	5	6	7
Jan. 1	4.45	4.75	4.95	4.90	5.05	5.35	5.30	9.0	12.0	16.5	32.0	44.0	65.0	110.0
Apr. 30							5.39							
Aug. 20							5.30							

[1] Zone A: Gulf coast ports: Galveston, Houston, Port Arthur, New Orleans, etc.; for coastwise delivery in North America.
Zone B: Arkansas, Colorado, Kansas, part of Missouri, New Mexico, and Texas except coastal ports.
Zone C: Pacific coast.
Zone D: Illinois, Iowa, and Wisconsin.
Zone E: Florida, Georgia, Indiana, Kentucky, Michigan, Ohio, Tennessee, West Virginia, and parts of New York and Pennsylvania.
Zone F: Atlantic Seaboard States: Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, parts of Pennsylvania, Rhode Island, South Carolina, Vermont, and Virginia.
Zone G: Mexico.

MISCELLANEOUS COMMERCIAL GASES

By FRANK L. HESS AND M. E. WINSLOW

SUMMARY OUTLINE

Gases are fluids without fixed external form that tend to expand indefinitely and to dissipate if not confined. Minerals are substances occurring in nature, of definite or approximately definite chemical composition and not of immediate organic origin. Most people think of minerals as solids or liquids, yet by the preceding definition the gases comprising the air are minerals, even though they are invisible, intactile, and seemingly imponderable. Some of these unseen, unfelt substances have become important commodities, and this chapter is intended to give a brief résumé of some of their commercial phases. Numerous combustible natural gases are also minerals, but they are discussed in other chapters of the Yearbook.

The great source of free gases is, of course, the air or atmosphere. It is commonly known that animal life depends for its existence upon the oxygen of the air and that plant life must have "fixed" nitrogen—that is, nitrogen in chemical combination—and carbon dioxide. After the discovery of oxygen by Scheele and Priestley a little more than 160 years ago nitrogen was soon recognized, though it was not the discovery of any one man. Later it was found that the atmosphere contained a little carbon dioxide (CO_2), but it was not until the 1890's that a group of inert elemental gases was definitely discovered in the atmosphere. Naturally the first to be isolated was the most plentiful. Rayleigh and Ramsay discovered it in 1894 and named it argon. In 1868 Lockyer discovered helium in the sun, in 1895 Ramsay and Crookes found it in pitchblende (in which it is formed by degradation of the element uranium), and later it was found in the air. In 1898 Ramsay and Travers discovered the still rarer atmospheric gases neon, krypton, and xenon.

In fact, helium, neon, argon, krypton, and xenon ordinarily are known as the rare gases. Like other gases of the atmosphere, they are invisible, odorless, and tasteless but differ from the other atmospheric gases—oxygen, nitrogen, and carbon dioxide—in being monatomic (that is, having only 1 atom in a molecule) and totally inert. From their inertness, which greatly exceeds that of the "noble metals"—gold, silver, and the platinum group—they have been called the "noble gases." Their inertness and rarity retarded earlier discovery of their presence in air.

Most of the information on rare gases in this chapter has been supplied by F. P. Gross, who has published numerous reports on the subject.

PROPERTIES OF GASES

The uses and methods of isolating gases depend, of course, upon their properties. Some of the more prominent characteristics of air and its component gases and of other common gases, including several considered in this chapter, are shown in the following tables:

Some properties of gases

Name	Chemical symbol	Under a pressure of 760 mm of mercury					Under a pressure of 760 mm of mercury at 60° F.		
		Boiling point		Melting or freezing point		Grams per liter at 0° C.	Weight, pounds per 1,000 cubic feet	Specific gravity compared to air	Cubic feet per pound
		° C.	° F.	° C.	° F.				
Air	Mixture	−193	−315			1.2929	76.363	1	13.1
Nitrogen	N_2	−195.814	−320.467	−209.9	−345.8	1.251	73.863	.968	13.5
Oxygen	O_2	−182.963	−297.337	−218.9	−362	1.429	84.404	1.105	11.8
Argon	A	−185.84	−302.53	−189	−308.2	1.783	105.28	1.379	9.5
Carbon dioxide	CO_2	−78.5	−109.3	−56.6	−69.9	1.9769	116.76	1.529	8.56
Hydrogen	H_2	−252.6	−422.7	−259	−434.2	.0899	5.309	.070	188.6
Neon	Ne	−245.9	−410.6	−248.7	−415.7	.900	53.169	.696	18.8
Helium	He	−268.98	−452.2	−272.2	−458	.1785	10.543	.138	94.85
Krypton	Kr	−151.8	−241.2	−169	−272.2	3.708	219	2.868	4.57
Xenon	Xe	−109.1	−164.4	−140	−220	5.851	345.6	4.525	2.88
Fluorine	F_2	−187	−304.6	−233	−387.4	1.696	100.1	1.312	10
Sulphur dioxide	SO_2	−10	−14	−72.8	−99	2.9269	172.87	2.264	57.8
Chlorine	Cl_2	−33.6	−28.5	−102	−151.6	3.214	189.83	2.486	5.27

1 cubic foot=28.317 liters.
1 gram=15.432 grains.
1 pound=7,000 grains.

Mellor[1] comments as follows on the paradoxical figures for carbon dioxide that show a melting (freezing) point 21.6° C. (38.9° F.) higher than its boiling point:

> M. Faraday pointed out that, owing to the high vapor pressure of liquid carbon dioxide, it gives the paradoxical result that if the boiling point be defined as the temperature at which the vapor pressure just balances that of the atmosphere the boiling point of carbon dioxide is lower than its freezing point by about 22°C.

This is a purely technical definition that leads to an absurdity when the ordinary understanding of a boiling point—the temperature of ebullition of a liquid—is considered. As a matter of fact, carbon dioxide cannot exist as a liquid in an open vessel;[2] it will be either a solid or a gas and therefore has no boiling point in the ordinary sense of the word.

An interesting property of the rare gases is that of giving a colored glow when excited by an electric current; upon this their commercial applications are largely based, and it has made them familiar in "neon" advertising signs. Gross gives the following colors for the rare gases when an electric current is passed through them:

[1] Mellor, J. W., A Comprehensive Treatise on Inorganic and Theoretical Chemistry: Vol. 6, 1925, p. 30.
[2] Meyers, Cyril H., Carbon Dioxide in the Solid, Liquid, and Vapor States: Ice and Refrigeration, vol. 76, 1929, p. 535.

Color of rare gases when excited by an electric current[3]

Neon	Red.
Argon	Purple.
Helium	Pinkish violet.
Krypton	Pale violet.
Xenon	Sky blue (uncondensed discharge). Green (condensed discharge).

AIR

Estimates of the composition of dry air under normal atmospheric pressure at sea level (a barometric pressure of 760 mm of mercury) have varied considerably. The analyses in the following table probably represent the most reliable work on the subject.

Composition of air

Element	Chemical symbol	By volume		By weight
		Ramsay and Travers[1]	Metzger[2]	
		Percent		
Nitrogen	N_2	78.03	1 part in 1.282	75.539 percent.[3]
Oxygen	O_2	20.99	1 part in 4.764	23.024 percent.[3]
Argon	A	.93	1 part in 106	1.437 percent.[3]
Carbon dioxide	CO_2	.03	1 part in 2,940	0.052 percent.[3]
Hydrogen	H_2	.01	1 part in 10,000 (?).	
Neon	Ne	.0015	1 part in 65,000	1 pound in 44 tons.[2]
Helium	He	.0005	1 part in 200,000	1 pound in 725 tons.[2]
Krypton	Kr	.000005	1 part in 1,000,000	1 pound in 173 tons.[2]
Xenon	Xe	.0000006	1 part in 11,000,000	1 pound in 1,208 tons.[2]

[1] Ramsay and Travers. From Mellor, J. W., A Comprehensive Treatise on Inorganic and Theoretical Chemistry: Vol. 8, 1928, p. 5.
[2] Metzger, F. J. Traces from Tons: Ind. and Eng. Chem., vol. 27, 1935, p. 112 (estimates for A, Ne, He, Kr, and Xe).
[3] Ramsay and Travers, work cited, p. 7.

Whether a small amount of hydrogen really is present in the atmosphere has not been settled definitely. Determinations have varied widely, and Gross has told the author that there is no certainty that it does not come from water used as a lubricant in liquid-air machines. As shown in the table, Ramsay and Travers' estimate of H_2 in the atmosphere was 0.01 percent, and Mellor[4] gives 0.0033 percent.

To emphasize what a small part of the atmosphere the rare gases comprise, the proportions given in the table may be expressed in another way. A cube of air whose edge equalled the height of the Washington Monument (approximately 555 feet) would contain about 171,000,000 cubic feet; of this, 15½ cubic feet would be xenon, 177 cubic feet krypton, 855 cubic feet helium, 2,630 cubic feet neon, and 1,612,800 cubic feet argon. These figures are employed by Metzger in the article cited and show a larger content of rare gases in the air than Ramsay and Travers' estimates; they are, however, the result of experience in liquefying very large quantities of air.

[3] Gross, F. P., Jr., The Commercial Application of the Rare Gases and Nitrogen: Comp. Gas Mfrs. Assoc., 20th Ann. Rept., 1932, p. 79.
[4] Mellor, J. W., A Comprehensive Treatise on Inorganic and Theoretical Chemistry: Vol. 7, 1927, p. 89 3

LIQUID AIR AND OXYGEN

Liquid air.—Liquid air, used mostly as a source of oxygen, is now made in nearly 200 plants in the United States, one company alone having 50 columns in various parts of the country for the liquefaction of air and its separation into component gases. Compressing the air to a liquid reduces it to about one seven-hundred-and-ninety-second of its original bulk. To reverse the figures, 1 cubic foot of liquid air would make about 792 cubic feet of free air if allowed to expand under average atmospheric pressure. Concerning the manufacture of liquid air Krase [5] says:

> In liquefying air, use is made of the principle that when a compressed gas such as oxygen or nitrogen, or a mixture such as air is allowed to expand, one obtains a marked cooling, due to the Joule-Thompson effect, plus the effect due to any external work which the expanding gas is made to perform. For example, when air at 100 atmospheres and at ordinary temperature is allowed to expand freely down to 1 atmosphere, the drop in temperature is about 25° C. [This is the Joule-Thompson effect.] However, since the boiling point of liquid air is −193° C. at a pressure of 1 atmosphere, it is seen that spontaneous liquefaction by simple expansion is not practicable. In actual practice, use is made of a heat exchanger, a device in which the cold expanded gases are made to pass around a tube containing the ingoing compressed gases, thereby decreasing the temperature of the latter. With properly constructed apparatus the cumulative cooling effects obtained in this manner result in liquefaction of the air.
>
> Two general types of air-liquefying processes have been developed, both based on the principles mentioned above, but differing in the method of expansion. In the Linde process the gas is compressed to 200 atmospheres and expanded by simple outflow, thus making use only of the Joule-Thompson effect. In the Claude process the liquefaction of air is effected by expanding the gases in an ordinary compressed-air motor, thus obtaining a cooling effect due to external work as well as to the Joule-Thompson effect. This process has the advantage over the Linde process in that pressures only up to about 30 atmospheres are needed and only a short time is required to reach the liquefaction temperature.

Liquid air has been used rather extensively as an explosive and is known under various names, the commonest being LOX (L. O. X.). Cartridges of an organic substance, such as paper, filled with carbon black or wood pulp are soaked in liquid air and placed in drill holes. They cannot be tamped and must be fired by electric detonators. Liquid air evaporates so rapidly that the cartridges must be fired very soon after they are charged, and there can be no danger from missed shots. Although LOX has been employed in various mines and quarries of the United States, dynamite can be produced so cheaply here that competition is difficult. LOX is, however, used in Mexico, various South American countries, and Europe, especially Germany.[6]

As LOX is rather sensitive to shock,[7] in fact, more sensitive than standard grades of 60-percent nitroglycerin dynamite, the carbon has been made granular, various inert materials have been added, and the purity of the oxygen has been reduced by adding nitrogen.

Oxygen.—Although the atmosphere contains 20.99 percent by volume of oxygen it was difficult and expensive to obtain pure oxygen before processes were developed for producing liquid air cheaply and in large quantities. For laboratory use it formerly was made by electrolysis and by various chemical methods, but now convenient steel cylinders of nearly pure compressed oxygen can be purchased

[5] Krase, H. J., Fixed Nitrogen: Am. Chem. Soc. Mon. 59, 1932, pp. 301–302.

[6] Rice, George S., Data Concerning Use of Liquid-Oxygen Explosives in Germany: Rept. of Investigations 2163, Bureau of Mines, 1920, 2 pp.

[7] Clark, L. V., Absorbents for Liquid-Oxygen Explosives; Their Relation to Sensitiveness to Impact and Other Properties of L. O. X.: Rept. of Investigations 3169, Bureau of Mines, 1932, 21 pp.

so cheaply that the gas rarely is isolated by users unless very large or very small quantities are needed.

The extent of the oxygen industry is indicated by Bureau of the Census figures for plants isolating oxygen in 1933:

Alabama	3	Nebraska	2
Arizona	1	New Jersey	5
Arkansas	1	New York	6
California	9	North Carolina	1
Colorado	2	Ohio	20
Florida	2	Oklahoma	4
Georgia	2	Oregon	2
Illinois	7	Pennsylvania	19
Indiana	5	Tennessee	4
Iowa	2	Texas	12
Kansas	2	Utah	1
Kentucky	2	Virginia	5
Louisiana	5	Washington	4
Maryland	2	West Virginia	2
Massachusetts	3	Wisconsin	4
Michigan	8	Wyoming	1
Minnesota	5		
Missouri	6		160
Montana	1		

The use of oxygen in treating pneumonia and other respiratory diseases is well-known. It is, however, worth noting in this connection that the oxygen standard prescribed by the present (1925) United States Pharmacopeia is 98-percent oxygen by volume, whereas oxygen ordinarily sold for welding and other industrial purposes carries 99.5-percent oxygen. Manufacturers say that oxygen of 98-percent purity is so much less effective than the industrial grade that it is practically unusable for welding.

Most of the oxygen isolated is used with acetylene in welding iron and steel, a business that has grown to such proportions that nearly every garage, machine shop, and mine of any considerable size has its own welding equipment; to isolated plants this often permits large savings because broken machinery can be mended and new parts made which formerly had to be replaced or ordered from distant points. Oxygen of 99.5-percent purity is furnished in tanks (cylinders) of 2 sizes, holding, respectively, 220 cubic feet (19.6 pounds) and 110 cubic feet (9.8 pounds) under a pressure of about 2,000 pounds per square inch. The market price is 2 cents per cubic foot.

NITROGEN

Nitrogen is a comparatively inert component of the air. It is, however, essential to probably all plant and animal life, although only certain types of bacteria can handle it in other than nitrate form. Aside from its use as a fertilizer, small quantities of nitrogen suffice to fill present demands. A little is used in packing foods likely to become rancid in air, such as dried and malted milk, dried coconut, and nut kernels; this use may well be extended. Nitrogen is also used in washing out incandescent lamps to be filled with argon, and, as stated under Argon, a small quantity is used in such lamps to prevent arcing. It has been used for testing and maintaining sheathed telephone cables, for testing and clearing out pipe lines and pressure vessels, for an atmosphere in bright annealing of steel, and in other metallurgical processes where oxidation must be prevented.

The only nitrogen-containing mineral found in large deposits is soda niter, a sodium nitrate known as "Chile saltpeter" or simply as "nitrate." This salt has been mined in great quantities from, and only from, the pampas of Chile, where the deposits, in the writers' opinion, apparently are the work of bacteria which directly or indirectly make nitric acid from the air that combines with salts in the ground. Moisture sufficient for the life of the bacteria but insufficient to wash away the sodium nitrate formed is supplied by Pacific fogs.

Ammonia and nitric acid are now made synthetically in such large quantities that artificial is now taking the market from natural nitrate. Several of the processes used to "fix" nitrogen—that is, to combine it with some other element to make ammonia, nitric acid, or other nitrogen compounds—are described in the following paragraphs.

The earliest commercial processes were the Berkeland-Eyde and the Schönherr or Schönherr-Hesseberger. In these, air is driven through a 6- or 8-inch-diameter tube in which is an electric arc that in the Schönherr process may be more than 20 feet long; this combines part of the oxygen and nitrogen of the air into nitric oxide, NO, which is oxidized to nitrogen dioxide, NO_2. The dioxide combines with water to form a weak solution of nitric acid. The Schönherr process is estimated to use only 3 percent of the electrical energy. None of the three seems to be very efficient, so that they and a later variation known as the "Pauling system" can be employed only where electric power is very cheap.

Nitrogen is fixed as ammonia by the Haber-Bosch process and its many variations. With the aid of a catalyst nitrogen and hydrogen are made to combine under very high pressures (1,000 atmospheres, or 14,700 pounds per square inch) and high temperatures (1,000° C. or 1,832° F.). In some variations of this process all nitrogen was obtained by liquefying air and removing oxygen, moisture, and carbon dioxide, but now the hydrogen and part of the nitrogen are obtained from producer or water gas (made by blowing steam through incandescent carbon, such as coal, coke, or lignite) or from coke-oven gas. Either type of gas must be carefully purified; at some plants this is done by liquefaction. The gas then is enriched with pure nitrogen. After ammonia is formed it can be oxidized to nitric acid.

A third means of fixing nitrogen is to make it combine with calcium carbide (CaC_2) to form calcium cyanamide ($CaCN_2$), thus:

$$CaC_2 + N_2 = CaCN_2 + C.$$

Nitrogen is obtained by rectification from liquid air and fed into a charge of powdered calcium carbide with which is mixed a little fluorite. The process is started by heating part of the mass with an electric arc, after which the heat generated by the reaction continues the nitrification to completion. The crude cyanamide is a grayish black, stony mass containing about 60 percent $CaCN_2$, 20 percent CaO, 12 percent C (graphite), and 8 percent Fe_2O_3, Al_2O_3, SiO_2, and other impurities and is used as a fertilizer.[8] At a number of plants the cyanamide is changed to urea, $CO(NH_2)_2$, a better plant food.

Efforts to fix nitrogen by making sodium cyanide (NaCN) by treating sodium carbonate with carbon and atmospheric nitrogen

[8] Krase, H. J., The Cyanamide Process of Nitrogen Fixation; Fixed Nitrogen: Am. Chem. Soc. Mon. 59, 1932, p. 296.

have been made but apparently have not yet proved a financial success.

The consumption of combined nitrogen is huge, and the consumption of manufactured nitrogen compounds is, of course, very nearly the same as the output. The British Sulphate of Ammonia Federation annual report for the year ended June 30, 1934 (p. 1), gives the world consumption of contained nitrogen as shown in the following table. It will be noted that the peak consumption in 1929–30 was less than 5 percent higher than consumption in 1933–34, that the consumption of manufactured nitrogen compounds had increased 114,000 metric tons while the consumption of soda niter (Chile nitrate) had decreased more than 200,000 tons, and that the artificially fixed nitrogen more than supplied the entire agricultural consumption.

World consumption of elemental nitrogen, in metric tons

	1929–30	1930–31	1931–32	1932–33	1933–34
Manufactured nitrogen compounds	1,586,904	1,377,005	1,417,000	1,619,705	1,700,907
Chile nitrate	363,893	244,300	138,208	127,242	161,199
	1,950,797	1,621,305	1,555,208	1,746,947	1,862,106
Agricultural consumption	1,750,000	1,455,000	1,412,000	1,586,000	1,663,000

ARGON

As stated earlier, argon is one of the monatomic rare gases and forms 0.93 percent of the atmosphere by volume; however, it is a heavy gas, constituting 1.437 percent of the air by weight, a percentage large enough to allow considerable quantities to be collected in liquid-air plants where atmospheric gases are separated.

In the United States alone probably 1,000,000 cubic feet of argon are used annually to fill incandescent electric lamps—in the smaller lamps with a purity of about 99 percent A to 1 percent N_2 and in ordinary 50- to 100-watt lamps about 86 percent A to 14 percent N_2. Argon is used because the tungsten filament vaporizes somewhat in a vacuum and "smokes" the glass bulb, but the filament can be heated without so much vaporization and therefore can be made more luminescent under an inert gaseous atmospheric pressure. If the bulb were filled with argon at atmospheric pressure, heating of the filament would increase the pressure to a dangerous point; therefore the gas is put in at about one-third atmospheric pressure, and normal pressure is attained when the electric current is turned on. The nitrogen is said to prevent short-circuiting where the filament enters and leaves the lamp. Argon, being absolutely inert, does not combine with tungsten at any temperature, and its greater atomic weight makes it more effective than nitrogen, which is also inert to tungsten.

Small quantities of argon are also used in luminous tubes. Like other rare gases, argon is sensitive to electrical discharges and when pure, dry, and under very low pressure glows with a characteristic purple light.

In the large quantities used by electric-lamp manufacturers argon costs only about 50 cents per cubic foot. In smaller quantities it costs about $10 per liter, owing to the much greater cost of handling.

CARBON DIOXIDE

Probably carbon dioxide and its properties are more commonly known than those of any other gas, except perhaps heating and illuminating gas. We exhale it; we drink it in soda water and other carbonated beverages; we raise our bread with it; and we use it to smother fires and to keep ice cream solid in the summer sun. It is familiar in the smoke from our fires, and in mines.

The first extensive—and still the greatest—use of the gas as such was in "soda water", the name coming from the fact that carbon dioxide originally was made from soda (sodium bicarbonate) by the addition of an acid; small amounts still are made by this method. Later methods were to burn limestone or magnesite or to burn coke alone and absorb the carbon dioxide in caustic potash or caustic soda solution, thus separating it from the air. The solution then was heated to make it give up its load of gas, cooled, and sent back for another charge. This method, also, is still in use.

In nature carbon dioxide occurs abundantly in fumaroles and springs, and great reservoirs in the earth are tapped by wells. Even the fractional percentages in the air and the oceans amount to inconceivably large quantities. Artificial sources of carbon dioxide include smoke from furnaces and coal or wood fires of all kinds, smoke from limekilns (which contains not only the carbon dioxide from combustion but that driven from the limestone), electric furnaces making calcium carbide (these produce carbon monoxide, which can be catalyzed to carbon dioxide), brewers' vats, distilleries, and yeast vats. Attempts have been made to save the carbon dioxide from most of these sources and some of them are actively exploited. The carbon dioxide of commerce is estimated to come from the following sources in the percentages given: Fermentation, 40 percent; lime burning, 40 percent; coke burning, 10 percent; and wells, furnaces, sodium carbonate and acid, etc., 10 percent.

NATURAL SOURCES

Fumaroles and springs.—Some mineral springs, particularly the fumarolic springs in volcanic regions, give off large quantities of gases very rich in carbon dioxide. In Iceland [9] fumarolic gases carry as much as 87 percent carbon dioxide, accompanied by the disagreeable odor of hydrogen sulphide, of which 6.60 percent is present. At Lake Palici, Sicily, gas from a spring carries 94.7 percent carbon dioxide; at Vulcano, Italy, one fumarole gives off gas containing 59.6 percent carbon dioxide and 27.19 percent hydrochloric acid and sulphur dioxide, and another emits gas with 77.02 percent carbon dioxide and 17.55 percent hydrogen sulphide; on Santorin Island, in the Aegean Sea, gas carries 95.37 percent carbon dioxide and a trace of hydrogen sulphide; at Katmai, Alaska, gas contains 52.8 percent carbon dioxide and 20.5 percent hydrogen sulphide and hydrogen; and at Kilauea, Hawaii, gas carries 62.3 percent carbon dioxide and 12.8 percent sulphur dioxide. The carbon dioxide and hydrogen sulphide commonly are determined together.

Wells.—Many wells drilled for oil give off huge quantities of carbon dioxide. The Continental Oil Co. drilled three remarkable wells of this type in North Park, Jackson County, Colo. The first—the

[9] Clarke, Frank W., The Data of Geochemistry: U. S. Geol. Survey Bull. 770, 1924, pp. 261–271.

Sherman No. 1 well [10] 4 miles northeast of Walden, drilled in 1926—blew out daily 30,000,000 cubic feet of carbon dioxide (equivalent to about 1,800 short tons) with 500 barrels of oil; the carbon dioxide weighed about 20 times as much as the oil. It has been thought that the carbon dioxide is in liquid form and as it blows from the well freezes with the oil, making a mush of ice said to look like lemon sherbet, so that the well was called the "ice-cream well." In 1927 the Hoye No. 1 well, 4,875 feet deep, was brought in with the enormous daily capacity of 50,000,000 cubic feet of carbon dioxide (about 3,000 tons per day or at the rate of more than 1,000,000 tons per year) accompanied by a few barrels of oil. At such a rate this well could furnish the world with all the carbon dioxide it needs and still leave a large surplus. The Glenwood Springs No. 1 well in sec. 1, T. 9 N., R. 79 W., gave off a large quantity of gas containing 92 percent carbon dioxide.

A well near Mack, Colo., carried 60 percent carbon dioxide and the Parker Club well near Trinidad, Las Animas County, 40 percent. Near Shelby, Mont., wells about 3,100 feet deep give off gas carrying 57 to 82 percent carbon dioxide. In New Mexico 9 miles south of Wagon Mound, Mora County, wells flowing large quantities of carbon dioxide (67 to 98 percent) have been drilled; west of Estancia, Torrance County, the wells have given off carbon dioxide of 98 percent purity, and in northern Harding County, 95 percent. It is claimed that the gas from these New Mexican wells is entirely free from hydrogen sulphide.[11]

In Utah a well at Farnham, Carbon County, is said to have given off 10,000,000 cubic feet of gas daily, carrying 97 percent carbon dioxide; one on Helium Reserve No. 1 near Woodside, Emery County, carried 30 percent carbon dioxide; a well drilled by the Denver & Rio Grande Railroad at Woodside produced gas that was almost 100 percent carbon dioxide; gas from the Canyon No. 1 well of the Utah Southern Oil Co. near Goodridge showed about 97 percent carbon dioxide; and a well of the Marland Oil Co. near Greenriver gave off gas carrying 80 percent carbon dioxide and hydrogen sulphide, but the proportions are unknown.

In California a dozen wells are said to have been sunk to a depth of about 460 feet in sec. 4, T. 11 S., R. 13 E., near the south side of Salton Sea. An item in the technical press states that the gas was under a pressure of 165 pounds per square inch and carried 99.1 percent carbon dioxide and 0.9 percent air.

The enormous quantities of carbon dioxide available in these wells, the high pressure in the deeper wells, the appeal of the unusual, and the high cost of solid carbon dioxide have led logically to the erection of plants to utilize the gas. Such plants have been erected at Walden, Colo.; Farnham, Utah; Estancia, N. Mex.; and Niland, Calif. The plant at Walden was definitely abandoned, but it has been proposed that the gas be piped to Laramie, Wyo., and that dry ice be made from it for use in refrigerator cars to preserve fruits and vegetables. Not much information is at hand concerning the other plants.

In Mexico, wells carrying large quantities of carbon dioxide have been drilled, and 90 percent of the oil wells in the North Panuco heavy-oil district southwest of Tampico produce gas high in carbon dioxide.

[10] Miller, J. C., Geology of the North and South McCallum Anticlines, Jackson County, Colo., with Special Reference to Petroleum and Carbon Dioxide: U. S. Geol. Survey Circ. 5, 1934, pp. 21 et seq.
[11] Oil News, July 20, 1933.

One Mexican well gave gas carrying 95 percent carbon dioxide and 5 percent combustible gases, and wells blowing off in 1931 were ejecting 900 tons of carbon dioxide daily.[12] Pressures were about 1,000 pounds per square inch with a temperature of 100° F. One well blew wild in 1916 or 1917 and probably discharged 1,000 tons of carbon dioxide daily. After running freely until 1931, according to Martin the pressure was still about the same. If these figures are correct the wells would have poured out nearly 5,000,000 tons of carbon dioxide in 15 years. If the flow was only half that quantity the output was still enormous, though only a fraction of that from northern Colorado wells. Some solid carbon dioxide was made in 1930 in a small plant and shipped to New York,[13] but operation ceased, possibly on account of shrinkage in shipments due to volatilization.

Air and ocean.—According to Clarke,[14] "At 3 parts in 10,000 the carbon dioxide in the atmosphere amounts to about 2,200,000,000,000 tons", and also "The ocean is the great reservoir of carbonic acid." The ocean is estimated to contain about 44 mg of carbon dioxide per liter, about 33.6 grams or 0.6 cubic foot per cubic yard, with a total possibly 25 times as large as that in the atmosphere.

Small as is the percentage of carbon dioxide in the atmosphere, the quantity is sufficient to furnish all of the carbon for growing plants, trees, and animals, and for the carbon in coal beds. In the same way the fractional percentage in the sea has furnished the carbon dioxide for the billions of tons of lime carbonate locked in the shells of mollusks and the skeletons of corals and that in the limestone, marble, and dolomite beds. However, the percentage in either atmosphere or ocean is altogether too small to make the gas available for ordinary commercial exploitation.

ARTIFICIAL SOURCES

Fermentation vats.—The great quantities of carbon dioxide given off from vats where yeast and other ferments were working on carbohydrates early attracted attention as a commercial source of gas. This source is, of course, organic and not mineral, but the product is the same. The gas from fermentation vats contains either about 60 or more than 99.5 percent carbon dioxide, depending on the type of fermentation. The vats are easily enclosed, and the gas can be conducted away to be used. A distillery manufacturing 10,000 gallons of alcohol per day produces 66,000 pounds of carbon dioxide or nearly 20,000,000 pounds per year.[15] As ethyl alcohol weighs about 6.604 pounds per gallon the alcohol and carbon dioxide produced are of approximately equal weight. The Solvent Products, Ltd., Dagenham Docks, Essex, England, manufactures 0.5 to 0.75 pound of dry ice for each pound of alcohol produced from molasses.[16] It is not necessary to absorb the gas made by fermentation, but it must be freed from odors. Absorbing agents are activated carbon, silica gel, alcohol, potassium bichromate, sulphuric acid, glycerin, or a succession of these absorbents.

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[12] Martin, James W., Solid Carbon Dioxide from Mexico: Ind. and Eng. Chem., vol. 23, 1931, pp. 256–258.
[13] Martin, James W., work cited.
[14] Clarke, Frank W., The Data of Geochemistry: U. S. Geol. Survey Bull. 770, 1924, pp. 50, 148.
[15] Chemical and Metallurgical Engineering, vol. 32, Feb. 22, 1923, p. 192.
[16] Engineering, Carbon Dioxide Ice Plant at Dagenham: Vol. 186, 1933, pp. 163–164.

Lime burning.—As has been noted, the burning of lime evolves large amounts of carbon dioxide, and great quantities are now available commercially from this source. Here carbon dioxide is not only made by the fires used for heating the limestone, but the stone itself gives off large volumes after being heated to its dissociation temperature (817° C., 1,502.6° F.). A pure limestone contains 44 percent carbon dioxide, but the gases from limekilns are said to carry only about 15 to 18 percent carbon dioxide owing to the great amount of air necessary to keep the fires burning and sweep the gases out of the kilns. Sugar factories use carbon dioxide gas directly from the kilns or from gasometers. Sugar is separated from sugar-beet or sugar-cane juices as lime saccharate, and the lime is then separated and precipitated by its own carbon dioxide.

Magnesite (magnesium carbonate, $MgCO_3$) carries 52.4 percent carbon dioxide, an even greater proportion than that in limestone, and various industrial plants have used it as a source of the gas.

A less apparent source of carbon dioxide is in the manufacture of calcium carbide in electric furnaces. In this process lime is heated with coal, and the reaction may be represented roughly thus:

$$\frac{\text{Lime}}{CaO}+\frac{\text{Coal}}{3C}=\frac{\text{Calcium carbide}}{CaC_2}+\frac{\text{Carbon monoxide}}{CO.}$$

If the materials were strictly pure and the reaction followed the formula exactly the carbon monoxide given off would amount to 41 percent of the charge; under practical conditions, however, it probably amounts to somewhat more than 30 percent. The carbon monoxide is treated with steam in the presence of a catalyst, forming carbon dioxide and hydrogen; great quantities of carbon dioxide are made thus at Niagara Falls.

Coke.—Large quantities of coke are burned directly for the carbon dioxide evolved during combustion; the heat generated is used for power.

Gas from other fuels.—The demand for carbon dioxide has become so great that utilization of various waste gases has been attractive; one by one they have been employed, except the greatest source of all—the smoke from fuels—though, as stated above, gas from coke is employed to some extent. In 1934 the United States burned about 400,000,000 short tons of coal carrying possibly 70 percent carbon, or 280,000,000 tons, which, when burned with enough air, would make about 1,027,000,000 tons of carbon dioxide.

Ordinary flue gases, however, are too dilute for profitable treatment. The chimney gas from an ordinary househeating plant may contain 5 or 6 percent carbon dioxide, but in large, well-run boiler plants it may reach 16 percent carbon dioxide by volume. The theoretically possible maximum, in which all the oxygen of the air (considered to form 23 percent by weight) passing into the furnace is burned to carbon dioxide, would give 31.6 percent carbon dioxide by weight or 21 percent by volume. It is interesting to remember that the extreme volume of carbon dioxide would be the same as the volume of oxygen because the number of molecules remains the same. In combustion each oxygen molecule attaches an atom of carbon to itself, so the number of molecules in any given space remains the same, but the weight of each is increased 37.4 percent by the added carbon.

As far as known, no carbon dioxide is saved from the smokes of stoves and furnaces, owing to the cost of equipment which must in no way interfere with the draft or working of the furnace. Under certain conditions such a scheme may be feasible; it has even been proposed that carbon dioxide be separated from the smoke of steamers to be used in their refrigerating plants.

Preparation.—Carbon dioxide is sold in two forms, as liquid and as solid or "ice." It is estimated that in the United States about 100,000,000 pounds (50,000 short tons) are sold annually as liquid and between 60,000 and 70,000 tons as solid. In most plants utilizing the carbon dioxide from limekilns, furnaces, and other sources producing dilute gas the carbon dioxide is scrubbed to remove sulphur compounds and dust, absorbed in potassium bicarbonate or some other absorbent, boiled out, cooled, dried, scrubbed with potassium permanganate, and compressed. If to be used as liquid it is placed in cylinders; these are of two sizes, the standard size containing 50 pounds and a smaller size containing 20 pounds. The gross weight of the standard size is about 133⅛ pounds; the walls of the cylinders have a minimum thickness of 0.23 inch, an inside diameter of 8 inches, and a height of 51 inches to the top of the neck, into which is screwed a Tobin bronze valve covered by a removable protective cap. The larger cylinder contains 436.5 cubic feet of gas at 70° F. and atmospheric pressure; the contents would fill a cube about 7 feet 7 inches on an edge. The small cylinder contains 174.6 cubic feet of gas, which would fill a cube about 5 feet 7 inches on an edge. A space must be left above the liquid carbon dioxide in the cylinders; otherwise, if the temperature rose they would burst from the expansion of the gas.

If the carbon dioxide is to be used as a solid it is conducted to a "snow chamber", where sudden expansion of the liquid carbon dioxide solidifies it like snow. These particles then are compressed hydraulically into cubes, ordinarily 10 inches on an edge and weighing about 40 pounds, or into blocks 20 by 20 by 10 inches.

In making the snow, if the pressure is high (about 1,100 pounds per square inch) and the liquid carbon dioxide is cooled by the returning gas, about half of it is frozen. Unfrozen carbon dioxide is returned to be recompressed. In the Carba process, after snow is formed, liquid carbon dioxide is allowed to wet it, and the block is frozen solid without the use of hydraulic pressure. The capacity is said to be below that of the pressed snow machines.[17]

In 1934 Philipp Stapp, of Munich, was granted United States Patents 1981675 and 1981676 for a method of freezing carbon dioxide direct instead of spraying it to form snow.

Uses of liquid carbon dioxide.—Among numerous other uses carbon dioxide is commonly employed in hand fire extinguishers, and a stiffly foaming material having the bubbles filled with carbon dioxide is used in fighting fires in oil tanks and varnish vats. Many freight and passenger ships carry batteries of cylinders filled with carbon dioxide; when the cocks are opened the gas smothers fire by replacing the air that supports combustion.

Liquid carbon dioxide under the trade name Cardox is used as an explosive in coal mining. A steel cartridge containing an electric

[17] Reich, Gustave T., Solid CO_2 Technology Defers to Distribution Problems: Chem. and Met. Eng., vol. 38, 1931, pp. 272–273.

primer and a quantity of powdered aluminum is filled with liquid carbon dioxide. When the aluminum is fired the heat causes the carbon dioxide to expand and exert an enormous pressure, the end of the cartridge is blown out, and the coal is broken. It is claimed that less fine coal is made by this type of blasting and that there is no danger from handling or from missed holes.

Until 1923 cashew nuts were considered to be among the most risky foods to ship because so often they were attacked by vermin. In that year shippers adopted the process of replacing part of the air in packing cans with carbon dioxide or some other inert gas. This made such a difference in keeping of the kernels that the imports (mostly from India) increased from some 100,000 pounds in 1923 to 4,000,000 pounds in 1930 and 15,000,000 pounds in 1934.

The following uses of liquid carbon dioxide have been published by Pure Carbonic, Inc., and Dry Ice, Inc.:

Chemical industry: Manufacture of salicylic acid, aspirin, and urea; neutralizing excess alkali in brine solutions; recovery of inflammable solvents; antioxidant for analysis of tin; insecticide for fumigation; treatment of asbestos shingles; vehicle for distilling phthalic anhydride; furnace atmosphere for coating radio-tube wire.

Fire prevention and extinction: Gas and snow extinguishers, portable, fixed, marine, and submerged (for liquids); storage of materials; purging of gasholders, hydrogen-filled transformers, and condensers; revivification of foam-producing materials; inert atmosphere in tanks for welding.

Food-products industries: Egg preservation; inert-gas packing for coconut, milk powders, and cod-liver oil; soft drinks, seltzer, and carbonated water.

Mechanical: Spray painting; blowing out plumbing and gas lines in houses, illuminating-gas mains and lines, and electric-refrigerator lines; inflating air bags; pressure testing for tanks and pipe lines; transfer of inflammable solvents.

Medical: Carbogen (mixed with oxygen); humane killing of animals; frozen sections.

Refrigeration: Refrigeration machines in theaters, clubs, cafes, apartment houses, hotels, and office buildings.

Miscellaneous: Stimulating plant growth; coal mining; laboratory reagent in colleges, universities, and hospitals.

Uses of solid carbon dioxide.—Carbon dioxide ice is sold under the names Carbice, Carbonice, Cardice, Dioxice, Drikold, Dry Ice, Ice CO_2, and their foreign equivalents. In America, however, the term "dry ice" is used almost universally because of its aptness.

Carbon-dioxide ice has a melting point of −69.9° F. and about twice the refrigerating value of water ice. It has the distinct disadvantage of being too cold for ordinary refrigeration if objects are in close contact with it. Special refrigerators overcome this difficulty, and refrigerator cars are made practically gas-tight, with the dry ice in the top; it is said that this arrangement keeps the different parts of a car at remarkably even temperatures.

The ice-cream trade in this country uses by far the largest quantity of carbon dioxide ice of any single business. Among the less important but very interesting uses it may be noted that carbon dioxide ice is employed by certain machinery firms for chilling and thus shrinking pieces which must be forced into snug-fitting parts.

In the Netherlands the Labor Act of 1919 prohibits bakers from working between 8 p. m. and 5 a. m., thus preventing them from furnishing the fresh rolls desired for breakfast. It has been found that if fresh rolls and bread are frozen with dry ice and thawed just before they are wanted they cannot be told from those newly baked.[18]

In Germany the Trockeneis Beratungs- und Pressedienst, in cooperation with the Air Ministry and other organizations, has been experimenting with rain-making by sprinkling from airplanes as much as 2 tons of crushed dry ice on clouds. It is said that a heavy downpour was thus caused over the Zuyder Zee in 1933.

In large quantities carbon dioxide ice costs about 2½ cents per pound, which is said to be too low to be profitable; it retails at 5 to 10 cents per pound. Water ice retails at about one-fourth to one-half cent per pound in eastern cities. Carbon dioxide ice therefore must rely on its cleanliness, lack of bulk, greater ease of handling, and lower temperature to compete; these advantages have caused the business to grow since 1925 to between 60,000 and 70,000 tons per year.

The following uses of solid carbon dioxide have been listed by Pure Carbonic, Inc., and Dry Ice, Inc.

Food products.—Carton shipments of meat, poultry, sea food, butter, fruits and vegetables, fruit juices, and chocolate; barrel shipments of meat, poultry, glands, and offal; truck refrigeration of frozen foods, meat and poultry, fish, mushrooms, fruits and vegetables, butter, eggs, milk, and cheese; dispensing cabinets for frozen foods.

Ice cream.—Truck refrigeration; private-order packages; express shipments; hardening fancy forms; ice-cream cabinets; boxes for peddling; display cabinets.

Industrial.—Cooling and hardening aluminum-alloy rivets; construction of temporary gas plugs in telephone cables; low-temperature tests of oils; facilitating grinding and mixing of dyes and gummy products; freezing samples of rubber; chilling golf balls and rubber articles for trimming; drying ether and solvents by freezing out water; cooling varnish; expansion and shrink fits; cooling in electroplating and electrotyping; sulphonation and/or nitration; special process in making doughnuts and other flour mixes; cooling traps in manufacture of vacuum tubes.

Miscellaneous.—Cooling for personal comfort; freezing to stop flow in caissons and leaky pipes; laboratory experimental work; low-temperature drying of biological materials; cooling, freezing, and shipping serums; freezing quicksand in excavation work; fumigating grain; surging water wells; cooling oil for boring or honing motor blocks to close tolerance; preservation of corpses by morticians; experimental quick freezing of meat, poultry, fish, fruits, vegetables, and fruit juices.

Producers.—The following list of the principal producers of carbon dioxide in the United States, some owning a number of plants, was published in Chemical and Metallurgical Engineering in March 1934.

Liquid and solid

American Carbonic Co., Harrison, N. J.
The Liquid Carbonic Co., Chicago, Ill.
New England Alcohol Co., Everett, Mass. (10 tons daily).[19]

[18] Brett, Homer, New Applications of Dry Ice in the Netherlands: Am. Cons. Rept., Dec. 7, 1934.
[19] Added to list.

Parker Browne Co., Fort Worth, Tex.
Pure Carbonic Co. of America, New York, N. Y.
Zero Ice Corporation, Detroit, Mich.

Liquid only

California Carbonic Co., Los Angeles, Calif.
Carbo Chemical Co., Salt Lake City, Utah.
Carbonic Manufacturing Co., New York, N. Y.
Crystal Carbonic Laboratory, Atlanta, Ga.
National Carbonic Co., San Antonio, Tex.
Pacific Silicate Co., San Francisco, Calif.
Southern Oxygen Co., South Washington, Va.
Sparkling Carbonic Co., Cincinnati, Ohio.
Wall Chemicals, Detroit, Mich.
Washington Liquid Gas Co., Seattle, Wash.

Solid only

American Dryice Corporation, New York, N. Y.
Mathieson Alkali Works, New York, N. Y.
Michigan Alkali Co., New York, N. Y.
Nu Ice Corporation, Los Angeles, Calif.
Witt Oil & Gas Co., Albuquerque, N. Mex. (wells on Wilcox dome).

According to the Census Bureau the distribution of plants making liquid and solid carbon dioxide in 1933 was as follows:

Plants making liquid carbon dioxide

California	7	Washington	2
New York	5	Alabama	1
Illinois	4	Colorado	1
Michigan	3	Indiana	1
Ohio	3	Louisiana	1
Pennsylvania	3	Maryland	1
Tennessee	3	Minnesota	1
Texas	3	Missouri	1
Florida	2	North Carolina	1
Georgia	2	Virginia	1
New Jersey	2		
Massachusetts	2		50

Plants making solid carbon dioxide

California	4	Louisiana	1
Pennsylvania	3	Massachusetts	1
New York	2	Michigan	1
Ohio	2	Minnesota	1
Texas	2	Missouri	1
Colorado	1	New Jersey	1
Florida	1	Virginia	1
Georgia	1	Washington	1
Illinois	1		
Indiana	1		26

Plants for the manufacture of carbon dioxide ice have also been erected in many foreign countries, and an advertising and research agency called "Trockeneis Beratungs-und Pressedienst" was established in 1932 at Sigmarungen, Hohenzollern, Germany. This agency publishes an organ, "Das Trockeneis."

HYDROGEN

Hydrogen is familiar as the lightest gas and the principal lifting agent for airships and balloons. It comprises about one-ninth of the water in the oceans, lakes, and rivers and is present in all organic matter and in rocks, so that the total amount would be inconceivable even if given in round numbers on a tonnage basis. Clarke[20] approves the reports of traces of hydrogen in the atmosphere, but its quantity is not determined with the same consistency as the other gases of the air.

For laboratory use hydrogen can be generated by the action of sulphuric or hydrochloric acid on zinc or by the action of a solution of caustic soda or caustic potash on zinc or aluminum. A process patented in England uses powdered silicon, a concentrated solution of a caustic alkali, and paraffin. Very pure hydrogen is made by electric decomposition of water, wherein hydrogen is given off at the negative pole and oxygen at the positive pole.

Most of the hydrogen generated is obtained from water gas made by passing steam through incandescent carbon. The resultant mixture contains about 50 percent hydrogen, 40 percent carbon monoxide, 4 to 6 percent carbon dioxide, and 4 to 6 percent nitrogen.[21] It is claimed that by proper manipulation and in the presence of a catalyst such as nickel, cobalt, or iron oxide the carbon monoxide is made to react with steam at temperatures of 350° to 450° C. and pressures of 4 to 40 atmospheres, so that the products are almost wholly carbon dioxide and hydrogen, thus:

$$CO + H_2O = CO_2 + H_2.$$

The carbon dioxide is absorbed by water under pressure.

About 61 percent of the hydrogen used in making synthetic ammonia is produced by this method. About 15 percent more is obtained by the electrolysis of water. According to Emmett,[22] about 1 percent is also obtained from electrolytic dissociation of brine in which hydrogen and chlorine are produced in equal quantities. A representative coke-oven gas containing 50 percent hydrogen and 15 percent nitrogen may be used directly for the manufacture of ammonia by eliminating everything but the hydrogen and nitrogen and enriching the mixture with nitrogen. About 23 percent of the hydrogen used in making synthetic ammonia is produced in this way.

Many methods have been developed for large-scale production of hydrogen, including action of warm water on zinc coated with copper; action of hot water on an alloy of aluminum with small quantities of zinc and tin and a trace of mercury; steam on hot iron, with regeneration of the iron by carbon monoxide; steam on a mixture of iron and manganese heated to 800° or 900° C. (the metals are reduced simultaneously from an ore containing both); steam passed first over copper and then over iron; water heated under pressure to 300° C. on finely divided iron and carbon (a little ferrous chloride and the insertion of a copper plate greatly increase the speed of the reaction); passing steam over hot metallic sulphides, such as zincblende after which the SO_2 is scrubbed out with ammonia solutions; steam with hot sulphur vapor (800° C.); steam and phosphorus; and by breaking down methane (CH_4) by heating to 1,200° or 1,300° C. or at lower temperatures in the presence of catalysts. The products of breaking down methane are carbon and very pure hydrogen, and the process

[20] Clarke, Frank W., The Data of Geochemistry: U. S. Geol. Survey Bull. 770, 1924, p. 45.
[21] Emmett, P. H., Synthetic Ammonia; Fixed Nitrogen: Am. Chem. Soc. Mon. 59, 1932, pp. 207–209.
[22] Emmett, P. H., work cited, p. 207.

is in actual use. Methane and steam may also be used, giving hydrogen according to the reaction

$$2H_2O + CH_4 = CO_2 + 4H_2.$$

During the Great War a mixture called hydrogenite, composed of 5 parts of ferrosilicon carrying 90 to 95 percent Si, 12 parts of caustic soda, and 4 parts of slaked lime, is said to have been used to generate hydrogen for filling balloons. The mixture was ignited with a hot iron ball.

Acetylene (C_2H_2) has been broken down electrically to produce hydrogen for filling Zeppelins.[23] The carbon is deposited in a very finely divided state. As the reaction is exothermic benzene may be passed with it through a tube heated to 500° C., and both are decomposed. The petroleum oils also are broken up at high temperatures.

A method that is virtually a mode of condensed storage is to make calcium hydride, which gives up its hydrogen when water is added. One kilogram of the hydride gives up very rapidly 530 liters (18.7 cubic feet) of hydrogen at 0° C. and 760 mm.

The principal use of hydrogen is to make ammonia, but the most spectacular use, though a minor one, is for lifting airships. Under normal atmospheric pressure and at 15° C. 1,000 cubic feet of hydrogen weigh 5.31 pounds, and 1,000 cubic feet of air under the same conditions weigh 76.36 pounds. In other words, hydrogen would require an added weight of 71.05 pounds per thousand cubic feet to make it weigh as much as the same bulk of air, and this represents its extreme lifting force—the point at which theoretically it would neither rise nor sink. With any less weight it would rise. For comparison, helium (now replacing hydrogen to some extent because it is not explosive) weighs 10.5 pounds per 1,000 cubic feet and has an extreme lifting power of 65.8 pounds. For use in aircraft hydrogen must be dried carefully and freed from sulphur or arsenic compounds, which might attack the balloon fabric.

A use for hydrogen which may eventually require enormous volumes of the gas is in the hydrogenation of coal and its distillation products—tar, creosote, etc. In 1869 Berthelot reported that having sealed powdered coal and hydriodic acid in a glass tube and heated them to about 270° C. the nascent hydrogen given off combined with the coal to form hydrocarbons.[24] In 1914 Bergius and Bilwiller patented in Germany a process of changing coal to oil by treatment with hydrogen under pressure and formed the Bergin Aktien-Gesellschaft to carry on investigations on a commercial scale.

Since then a great amount of work has been done on different types of coal and on peat. Bituminous coal seems to be the best coal for the purpose, and tars distilled from coal are easier to treat than the coals themselves. The Imperial Chemical Industries of England claimed in 1933 that "spirit" (gasoline) could be made from English coal at 7d. per gallon.[25] Presumably the imperial gallon of 277.274 cubic inches is meant, and with the pound at \$4.2368 (as given by the Federal Reserve Board for 1933) the price would have been equivalent to about 10.3 cents per common gallon of 231 cubic inches.

[23] Redgrove, H. S., Hydrogen: Industrial Gases, 1916, p. 41.
[24] Quoted by Graham, J. Ivan, and Skinner, D. G., The Action of Hydrogen on Coal: Jour. Soc. Chem. Ind., vol. 48, June 14, 1929, pp. 129T–136T.
[25] King, J. G., The Hydrogenation of Coal: Coll. Guard., Nov. 17, 1933, p. 949.

A large plant for the hydrogenation of coal has been erected by the Imperial Chemical Industries at Billingham, a short distance north of Middlesbrough and Stockton on Tees, England. Some 300,000 gallons of "spirit" or "petrol", made from creosote, has been delivered; but "whether it will ever be possible to manufacture oil from coal by hydrogenation at such prices as will compete with the untaxed natural product must remain doubtful." [26]

In Germany brown coal is carbonized at low temperatures to obtain oils, and the oils are hydrogenated. The Coalite Co. in England follows a similar process.[27] The hydrogen is obtained from water gas or from other types of coal gas.

Methyl (methyl alcohol, methanol) may be made from the coke left from carbonization by burning it to CO and combining with hydrogen:

$$CO+2H_2=CH_3OH$$

In Germany it is said that the Interessen Gesellschaft, using the Bergius process, will produce 300,000 metric tons of oil during 1935, and the Trust of the Brown Coal Works estimates it annual production of petrol at 400,000 tons.[28]

A use for hydrogen that affects nearly every household is in the hydrogenation of oils. If "unsaturated" oils such as coconut oil or cottonseed oil are sprayed into hydrogen or treated with it under heat and pressure in the presence of a catalyst such as powdered nickel, platinum, or molybdenum new compounds are formed that are solid when cooled. Large quantities of these compounds are used in frying and shortening and in oleomargarine. The odor of whale oil, fish oil, linseed oil, and others similarly treated is destroyed and the color lightened, so that the products are suitable for soaps and other commodities.

Hydrogen burned with oxygen in the oxyhydrogen blowpipe gives a very hot flame; before electricity was commonly available the flame was played on a block of lime, which became dazzlingly incandescent and gave a light almost equal to that of an arc lamp. The blowpipe also was used for melting platinum. However, the oxyhydrogen blowpipe has been succeeded by the oxyacetylene blowpipe, which gives an even hotter flame. Hydrogen will also burn in chlorine, and part of that generated in caustic soda plants is thus burned to make very pure hydrochloric acid (HCl).

Hydrogen is used in some metallurgical processes where a reducing atmosphere is needed, and large quantities are employed to reduce tungsten and molybdenum from their oxides. Most tungsten for making electric-lamp filaments and high-quality tungsten carbide for tools is reduced by hydrogen.

NEON

Neon recently has become a familiar name from its extensive use in tubes for lighting signs, where its distinctive orange-red glow is unmistakable. Neon also is used in sodium vapor lamps, trouble finders for detecting faulty sparkplugs in automobile engines, lightning arresters, indicators for current in high-tension electric lines,

[26] Chemical Age (London), Chemical Industry and the Oil Problem: Vol. 32, June 22, 1935, p. 547.
[27] See footnote 26.
[28] See footnote 26.

glow lamps, and stroboscopic lamps. It is said that there is virtually no lag in the response of a neon tube to electric current.

Concerning the use of neon to fill tubes for illuminated signs, Gross writes:

The gas has an electrical conductivity 75 times as great as air. When in a rarefied condition, pure and dry, the passage of a high-tension electric current causes it to glow with a very beautiful and distinctive orange-red light. The commercial sign tube is simply a glass tube equipped with suitable electrodes which has been evacuated and filled with pure neon at a pressure in the neighborhood of 10 to 15 mm absolute. The current used is ordinarily 15,000 volts, 60-cycle a. c., with a current flow of 25 milliamperes. To make a blue tube it can be done simply by adding a few drops of mercury to an ordinary neon tube. However, this does not work out so well in cold weather for outdoor use since the mercury will tend to condense and the blue color will fade. To offset this, mixtures of neon and argon with mercury are ordinarily used. For extremely cold climates a tube that will run even hotter is required, and in these cases we simply add a little helium to increase the resistance. The disadvantage of adding helium lies in the fact that, as the resistance increases, the length of tubing that can be operated from a given transformer is cut down. In other words, we are getting more heat and less light for our input of electrical energy.

Briefly, the green tubes are the same as blue with the exception that in place of clear glass amber or uranium glass is used. The light rays other than green are filtered out, and in that way we get the so-called green tube, the exact shade of which depends on the color of the glass tubing and the background.

While we are on this general subject of sign tubes, we may as well include the remaining colors, namely, white and yellow. White is ordinarily made up with helium at very low pressures in clear glass. For the yellow or gold we change the color of the glass tubing to an amber just as we did to make a green tube. In other words, the only difference between the green and blue is in the color of the tubing, and likewise the only difference between the white and the yellow is in the tubing. A trace of some of the other rare gases is sometimes introduced into a helium tube with the idea of securing a somewhat lower voltage drop, but in the main the helium tube has not yet been improved on. A really satisfactory white with proper operating and electrical characteristics is much to be desired.

Announcement of a new low-voltage white light has just come in from the Pacific coast. Various small-diameter tubes of different colors are combined to produce a synthetic white. This is adapted for fixtures in stores and show-case illumination, color matching, et cetera.

Due to the low pressures used in this work, not much gas is required even though our advertising signs are literally plastered with neon and other gas tubes. One cubic foot of neon will fill about 4 miles of average sign tubing. In fact, the gas cost is the smallest part of the total cost of a neon sign.

On this question of rare gases for vacuum tube work, let me stress the fact that purity is essential. The presence of any gas in neon other than helium ruins its light-giving qualities. This means, then, that not only do we have to make these gases pure but the users have to take steps to maintain that purity. All active gases, such as nitrogen, oxygen, carbon dioxide, water vapor, must be kept out.

On the other hand, the addition of small amounts of other rare gases will many times change the electrical characteristics of a given rare gas. It is a common thing to make up a mixture of one gas containing, for example, 0.04 or 0.1 percent or some other percentage of that order. This rare-gas work calls for laboratory attention of the highest order. The main point to remember here is that anything that is done with these rare gases must be by physical means rather than chemical due to the fact that they are inert. In other words, they do not react chemically with anything else. Consequently, it is necessary to use adsorption processes for the most part.

Along this line we may expect, eventually, the use of neon to become more widespread but probably on the basis of inherent advantages over incandescent lamps just as the neon tube has largely replaced the incandescent lamp for display-sign use.

On this point, the following comparison between a neon roof sign with an equivalent incandescent-lamp sign is of interest: While the total cost of the neon sign was about $2,500 and the incandescent lamp job was figured at $2,100, the current cost per hour for the former is 14 cents, whereas for the latter it would be 90 cents.

We may expect, in general, the use of neon discharge tubes for illumination to increase since it is not possible to get as good efficiencies with the filament type of bulb due to the heat developed along with the light. In a recent article of Georges Claude appearing in the Comptes Rendus some low-voltage tubes are described which produce the same lighting with a consumption of 36 kilowatts that would have required 50 kilowatts with ½-watt lamps and the latter would not have given the same quality of light. As more work is done with low voltages we may expect further progress along this line. Furthermore, development of hot cathode tubes should do much to further the use and application of neon and the other rare gases in the field of illumination.

Although Gross states that 1 cubic foot of neon will fill about 4 miles of tubing, it is said that the waste in handling is so great that in practice many times that quantity is used.

KRYPTON AND XENON

Except for the evanescent radioactive triplets radon, thoron, and actinon, krypton and xenon are the heaviest and rarest gases. There are only 4.57 cubic feet of krypton and 2.88 feet of xenon to the pound compared with 188.6 cubic feet of hydrogen; and about 1 part in 1,000,000 of krypton and only 1 part in 11,000,000 of xenon are found in the atmosphere. Radium is the only other element extracted from such a lean material, but radium has chemical affinities and remarkable physical properties that make it readily traceable, whereas krypton and xenon are inert and colorless and can be separated only by rather obscure physical properties, principally their low boiling points.

Hitherto no use has been made of krypton or xenon, but if demand materializes moderate quantities could be saved from liquid-air columns. If sufficient amounts were available these gases would increase the efficiency of electric lamps. At present probably 25 liters can be isolated yearly, and the price is about $250 per liter.

SULPHUR DIOXIDE

When sulphur or any sulphide is burned in the air the sulphur combines with oxygen to form sulphur dioxide (SO_2), the pungent, irritating, colorless gas familiar to all who have used old-style sulphur matches. Huge quantities are given off by volcanoes in eruption and smaller volumes by fumaroles, but none is saved. Although large quantities of sulphur dioxide are produced in the roasting of pyritic ores, galena, zinc blende, and copper ores it is made into sulphuric acid if saved at all. The sulphur dioxide of commerce is made by burning sulphur. The gas is easily liquefied, requiring a pressure of only 66.4 pounds per square inch at 86° F.[29] When compressed it forms a colorless liquid which has a specific gravity of 1.46 at its boiling point (−11° C., 12.2° F.)[30] and is shipped both in steel cylinders and tank cars. If perfectly dry it does not attack most metals.

Sulphur dioxide is used in millions of mechanical refrigerators, having the advantage that leaks are found easily when a bottle of ammonia hydrate is brought near.

In addition to this principal use, small quantities are consumed for bleaching and sugar making. Made in place by burning sulphur, large amounts are used in bleaching and preserving fruit to be dried.

[29] Eustis, F. A., Liquefied Sulphur Dioxide: Comp. Gas Mfrs. Assoc. 20th Ann. Rept., 1932, p. 63.
[30] Greenwood, Harold C., Industrial Gases: 1919, pp. 54-55.

Other large quantities are made and used in sulphite pulp mills for bleaching wood fiber for paper making.

According to the Bureau of the Census 5 plants (2 in New Jersey, and 1 each in California, Virginia, and Wisconsin) made liquid sulphur dioxide in 1934.

The Census Bureau reports production for sale as follows:

Year	Pounds	Total value	Average value per pound
1929	17,600,936	$973,596	$0.0553
1931	16,104,534	839,021	.0520
1933	19,559,779	967,657	.0495

CHLORINE

Chlorine is an acrid, choking, heavy, greenish-yellow gas that probably does not occur free in nature, owing to the avidity with which it attacks other elements; it does, however, occur in combination as hydrochloric acid and ammonium chloride in some volcanic gases and as sodium chloride (salt) in the oceans and in the great salt beds. Although there are many other natural chlorides their occurrence compared to that of salt is comparatively insignificant, and it is from salt that chlorine is obtained.

Chlorine becomes a liquid under normal atmospheric pressure (760 mm) at −33.6° C. (−28.5° F.). At 70° F. it requires a pressure of 86 pounds per square inch for liquefaction. At 0° C. (32° F.) the liquid has a specific gravity of 1.47, so that 1 cubic foot weighs 91.770 pounds; 1 cubic foot of the gas itself weighs 0.198 pound.

Most of the chlorine made commerically is obtained by electrolytically decomposing brine, caustic soda being made and chlorine and hydrogen evolved. The reaction may be expressed by the equation

$$2\ NaCl + 2\ H_2O = 2\ NaOH + H_2 + Cl_2.$$

In this process equal volumes of chlorine and hydrogen are given off, but the chlorine weighs about 35.46 times as much as the hydrogen.

Sodium is made by electrolysis of molten salt, and chlorine is given off as a byproduct. When sodium and caustic soda first were made at Niagara Falls the byproduct chlorine was regarded as a disagreeable nuisance to be disposed of in the easiest way possible, but when the byproduct increased to many tons a day the problem became serious, and considerable thought and effort were expended in making the gas a source of profit.

Fortunately chlorine is compressed easily to a liquid, and unless moisture is present iron and steel are not attacked by it below a temperature of 80° C. (176° F.). Above that temperature they will burn in the gas, characteristics that make practicable its shipment in cylinders of various sizes and in tank cars holding as much as 15 tons. A very little water makes chlorine immediately attack iron, steel, and other metals.

The first shipment of chlorine in this country is said to have been six 100-pound cylinders from the Electro Bleaching Gas Co. in 1909, and the gas sold for 25 cents per pound.[31] Now regular tank-car shipments are made at prices less than a fifteenth as much.

In 1932 Joseph Kalish [32] published a list of plants in the United States, with their capacities; this is given below with one addition.

Chlorine plants in the United States, with daily capacity in short tons of chlorine

Belle Alkali Co., Belle, W. Va	18
Diamond Alkali Co., Painesville, Ohio	18
Dow Chemical Co., Midland, Mich	100
E. I. du Pont de Nemours Co., Inc., Deepwater, N. J	9
E. I. du Pont de Nemours Co., Inc., R. & H. Works, Niagara Falls, N. Y	10
Great Western Electrochemical Co., Pittsburgh, Calif	36
Hooker Electrochemical Co., Niagara Falls, N. Y	72
Hooker Electrochemical Co., Tacoma, Wash	27
Isco Chemical Co., Niagara Falls, N. Y	13. 5
Mathieson Alkali Works, Niagara Falls, N. Y	45
Mathieson Alkali Works, Providence, R. I	13. 5
Monsanto Chemical Works, East St. Louis, Ill	13. 5
Niagara Alkali Co., Niagara Falls, N. Y	36
Pennsylvania Salt Manufacturing Co., Wyandotte, Mich	115
Pennsylvania Salt Manufacturing Co., Menominee, Mich	Small
Pennsylvania Salt Manufacturing Co., Tacoma, Wash	9
Solvay Process Co., Syracuse, N. Y	36
Westvaco Chlorine Products Corporation, South Charleston, W. Va	145
	716. 5

Counting the daily capacity for 360 days a year would given an annual capacity of about 258,000 tons. The Chlorine Institute, Inc., 50 East Forty-first Street, New York, lists 43 producers in the United States having a total annual capacity of 344,534 tons of dry chlorine but gives no individual capacities.

The purity of ordinary commercial chlorine is said to be greater than 99.8 percent.[33] The production as collected on alternate years by the Bureau of the Census has been as follows:

Year	Amount for sale	Value	Value per pound	Total production
	Pounds		*Cents*	*Pounds*
1929	289, 854, 850	$7, 113. 091	2. 45	398, 943, 703
1931	255, 510. 687	5, 248, 496	2. 05	361, 739, 705
1933	249, 125, 505	4, 486, 325	1. 80	428, 177, 566

Owing to the concentration of production at Niagara Falls average prices for New York are not as high as for the rest of the country; in 1933, 121,725,636 pounds valued at $2,004,576 or 1.64 cents per pound were isolated and compressed for sale in that State. Most, if not all, of this was produced at Niagara Falls.

Chlorine is the greatest bleaching agent, and much the largest part is used for that purpose. In 1926 Pritchard [34] estimated consumption as follows: Paper industry, 65 percent; textile industry, 22 percent; sanitation, 10 percent; other uses, 3 percent. There probably has been no great change in the relative uses since this estimate was published.

31 Haynes, Williams, Chlorine, Caustic and Company: Chem. Ind., vol. 36, February 1935, p. 113.
32 Kalish, Joseph, Our Chlorine Supplies: Chem. Markets, vol. 30, 1932, pp. 147-149.
33 Savell, W. L., Our Chlorine Deliveries: Chem. Markets, vol. 30, 1932, p. 151.
34 Pritchard, D. A., Economics of the Chlorine Industry: Chem. and Met. Eng., vol. 33, 1926, p. 353.

Concerning the use of chlorine in sanitation A. H. Hooker, of the Hooker Electrochemical Co., Niagara Falls, N. Y., says:[35]

> Perhaps less than 5 percent of the chlorine used in the States enters into water purification. Little more than 25 years ago I remember while living in Chicago that I had a serious case of typhoid fever, due to the water which was then supplied that city. Typhoid was prevalent everywhere. In 1898, during the Spanish-American War, our soldiers died like flies in camp at Chickamauga due to typhoid. In 1910 typhoid was the most common disease and held the largest number of patients in hospitals in Niagara Falls. Shortly after that filtration and treatment with chlorine of the water supply for Niagara Falls changed this condition almost overnight and * * * the disease has practically died out. This change has taken place in the last 25 years, largely due to the use of chlorine in the water supplies of the country, and has been one of the most radical health reliefs that has occurred in our generation. * * *
>
> I think we will point with even greater pride to the use of proper mechanical equipment and chlorine as a means of taking care of our sewage and will, within a few years, wonder how this generation stood for the stream pollution that now goes on.

Among the "other uses" to which 3 percent of the chlorine consumed is assigned are: Manufacture of chloroform, chlor-naphthalene, chlor-benzol, para-dichlor-benzol, carbon tetrachloride, artificial plastics, very pure hydrochloric acid, and sulphur dichloride; separation of zinc from molten lead; and prevention of slime growth in pipes in paper mills and feed-water lines. One ingenious application is in the detinning of steel; on dry, clean, tin plate the tin is attacked by dry chlorine but the steel is not, so that the tin can be recovered as tin tetrachloride, used in weighting silk.

Chlorine was the first of the poisonous gases to be used in warfare, and its distressing and lasting ill effects are well-known; most of the other war gases since developed also contain chlorine as a component.

[35] Hooker, A. H., Uses of Chlorine: Comp. Gas Mfrs. Assoc. 20th Ann. Rept., 1932, pp. 61–62.

HELIUM

By H. S. Kennedy and C. W. Seibel

SUMMARY OUTLINE

Helium is produced by the Bureau of Mines for the inflation of airships operated by the Army and Navy. This undertaking is unique among Government activities in that it is probably the only instance in which the raw material is produced and the final product manufactured and used by the Government itself. The recognition in 1905 of helium as a constituent of natural gas remained in the status of a scientific discovery for many years. Therefore, when the Government undertook production on a large scale in 1918 for aeronautical use it was forced to secure a source of the raw material and supervise the development of a process for its separation. Brief descriptions of the early experimental work and the operation of the Government's Fort Worth plant, which produced about 48,000,000 cubic feet of helium in 8 years, have been given by Stewart.[1]

The Government's efforts in establishing helium reserves and plants were summarized and storage, transportation, foreign supplies, exports, uses, future possibilities, and non-Government production were discussed in Minerals Yearbook, 1934, pages 757 to 764.

Cliffside gas field.—When the anticipated shortage of helium-bearing natural gas that supplied the Fort Worth plant became a reality the Bureau of Mines selected the Cliffside structure near Amarillo, Tex., as the most promising new source of supply in consequence of extended surveys by the Bureau for helium-bearing gas. Equally important factors considered in selecting a source of supply were the helium content (about 1.8 percent) and the quantity of available gas. Other influencing factors studied were the character and quantity of other constituents of the gas, such as carbon dioxide, which make extraction of helium more difficult and expensive. Moreover, if the heating value of the gas is high enough it can be used for generating power in the extraction process, and after the helium has been removed the residue gas can be sold as fuel.

The development of the Amarillo project was undertaken to secure helium supplies for many years so as to assure the Army and Navy a reliable and continuous source of noninflammable lifting gas for the airships being developed for national defense. Conservation of this gas in the ground until needed for production of helium was of paramount importance and was accomplished by purchasing the gas mineral rights in fee for the 50,000 acres comprising the whole Cliffside structure. This had the desirable result of preventing possible

[1] Stewart, Andrew, About Helium: Inf. Circ. 6745, Bureau of Mines, 1933, 46 pp.

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drainage of the gas to offset properties, with the probability that the gas would be produced and used as ordinary fuel gas, thus wasting the helium.

In operating the Cliffside field the Bureau withdrew 3,880,000,000 cubic feet of natural gas from the field between May 16, 1929, when it acquired ownership of the gas properties, and December 31, 1934. This withdrawal represented only about 2 percent of the total reserves, as indicated by the rock pressure over a period of 6 years. Five gas wells have now been drilled on the structure, with a combined initial open-flow of 41,000,000 cubic feet per day. This developed capacity permits a conservative type of operation by allowing a small withdrawal from a wide area, thereby equalizing the pressure in the structure and preventing the establishment of drainage channels for uneven encroachment of water.

Amarillo helium plant.—The Bureau of Mines helium plant was constructed near Amarillo, Tex., in accordance with designs developed by Bureau engineers and was placed in operation in April 1929. Virtually all the separation equipment is of special design, and much of it was fabricated in the plant shops. In simple outline the separation involves liquefying all the constituents of the gas except the helium, continuously trapping off the liquids at the bottom of a container, and removing the helium as a gas at the top. However, in actual practice the process is complicated. The gas enters the plant at a pressure of about 600 pounds per square inch. As a first step the carbon dioxide is removed by scrubbing the high-pressure gas with caustic soda solution, because if the carbon dioxide were not removed it would solidify in the tubing and stop the flow of gas through the plant. The gas, freed of its carbon dioxide, is cooled to about 300° F. below zero, and approximately 95 percent is liquefied. This is accomplished by a series of heat exchangers, aided by an auxiliary nitrogen-gas cycle in which the nitrogen is compressed to 500 pounds per square inch and expanded through an engine, causing it to do mechanical work, thus cooling the exhaust gas progressively. The cooling produced by expanding the incoming gas from 600 to 75 pounds per square inch, aided by the auxiliary nitrogen cycle, produces a crude helium which is about half helium and half nitrogen.

This crude helium is compressed to 2,000 pounds per square inch and cooled by heat interchange with cold partly liquefied nitrogen. Almost all the nitrogen in the crude helium is liquefied by this process, which produces a gas of more than 98 percent helium purity. The gas passes from the purification cycle into containers for shipment at a pressure of about 2,000 pounds per square inch.[2]

The separation process is unique in that the raw material, the gas in the process of separation, and the finished product are not visible. The process is conducted inside the equipment at high pressures and low temperatures and involves a change of phase of several hundred volumes of gas to 1 volume of liquid, resulting in sensitive and fluctuating liquid levels and requiring exact control by pressure gages, electric temperature recorders, and liquid-level gages.

In the 6 years prior to December 31, 1934, the Amarillo plant produced 64,860,410 cubic feet of helium. Expenditures in plant and gas-field operation have been $736,363.78, giving an all-time

[2] For a more complete description of the Amarillo plant see Seibel, C. W., The Government's New Helium Plant at Amarillo, Tex.: Chem. and Met. Eng., vol. 37, no. 9, September 1930, pp. 550-552; also Anderson, C. C., The Government's Helium Projects in Texas: Petrol. Eng., September 1932, pp. 102-105.

average gross operating cost for the plant of $11.35 per thousand cubic feet of helium. However, sale of the residue gas has returned $178,473.48 to the National Treasury. Thus, the net outgo from the Treasury for operation has been only $557,890.30, or $8.60 per thousand cubic feet of helium produced.

During the past few years production of helium by non-Government plants has been of the order of 1,000,000 cubic feet per year.

Government helium production and costs, April 1921 to December 1934

Period	Production[1]	Gross operating cost (expenditures in operation and maintenance)[2]		Return from sale of residue gas	Net operating cost (gross operating cost less return from sale of residue gas)[2]	
		Total	Average per M cubic feet produced		Total	Average per M cubic feet produced
Fort Worth plant:[3]						
Under jurisdiction of Navy Department:	*Cubic feet*					
April to June 1921	260,520	$126,694.05	$486.31			
July to December 1921	1,841,000	320,859.73	174.28			
October 1922 to June 1923[4]	4,069,940	489,299.70	120.22			
July 1923 to June 1924	8,204,665	636,438.38	77.57			
July 1924 to June 1925	9,418,363	451,084.58	47.89			
	23,794,488	2,024,376.44	85.08			
Under jurisdiction of Bureau of Mines:						
July 1925 to June 1926	9,355,623	318,446.40	34.04			
July 1926 to June 1927	6,330,056	277,384.70	43.82			
July 1927 to June 1928	6,687,834	274,210.54	41.00			
July 1928 to Jan. 10, 1929	2,638,894	121,440.65	46.02			
	25,012,407	991,482.29	39.64			
Amarillo plant:[5]						
Under jurisdiction of Bureau of Mines:						
April to June 1929	844,900	27,833.16	32.94	$2,645.32	$25,187.84	$29.81
July 1929 to June 1930[6]	9,805,600	140,146.75	14.30	30,445.43	109,701.32	11.19
July 1930 to June 1931	11,362,730	150,190.53	13.22	32,510.24	117,680.29	10.36
July 1931 to June 1932	15,171,680	148,545.26	9.79	40,862.43	107,682.83	7.10
July 1932 to June 1933	14,749,960	151,165.51	10.25	37,661.70	113,503.81	7.70
July 1933 to June 1934	6,534,270	63,528.33	9.72	17,585.94	45,942.39	7.03
July to December 1934	6,391,270	54,954.24	8.60	16,762.42	38,191.82	[7] 5.98
	64,860,410	736,363.78	11.35	178,473.48	557,890.30	8.60

1 Production from the Fort Worth plant represents volume of airship gas produced, which had an average helium purity of 93 to 94 percent under Navy jurisdiction and about 95 percent under Bureau of Mines jurisdiction. Production from the Amarillo plant represents actual helium in the airship gas of better than 98-percent purity produced by that plant. Therefore, the advantage of the Amarillo plant from standpoint of cost is about 5 percent greater than a direct comparison of the figures indicates.

2 Gross operating costs for the Fort Worth plant represent expenditures in operating and maintaining the plant, including current expenditures for natural gas. The Government did not own the gas field that supplied the Fort Worth plant, so there was no return from sale of residue. Gross operating cost for the Amarillo plant represents expenditure in operating and maintaining both the plant and the Government-owned gas properties. This gross operating cost at Amarillo is a measure of the amount that must be available to the Bureau of Mines for current expenditure. Returns from sale of residue gas, in excess of its cost, must be deposited to credit of miscellaneous receipts of the Treasury and therefore are not available for expenditure by the Bureau. As the net operating cost is computed by subtracting current returns from current expenditures, it is a measure of the net withdrawal of funds from the Treasury for operation and maintenance.

3 Costs at the Fort Worth plant are based on compilations by the Bureau of Efficiency from records of the Navy Department and the Bureau of Mines. (Report of Bureau of Efficiency in hearing on Amarillo helium plant before the Committee on Mines and Mining, House of Representatives, 71st Cong., 2d sess., p. 210.) The costs do not include depreciation or depletion, and those for period of Navy jurisdiction do not include cost of Washington administration.

4 Plant closed in 1922 from January to September, inclusive, because of lack of funds.

5 Compiled from Bureau of Mines records. The costs do not include depreciation or depletion.

6 Plant shut down entire months of December 1929 and February 1930 because the Navy purchased its helium elsewhere at $34 per thousand cubic feet. Stand-by costs for these 2 months were $19,181.14.

7 Unit costs for year 1934 abnormally low because of Government pay cuts, furlough of employees, and reduction of plant crew to the minimum required to man plant and gas field for intermittent operation. In normal times considerably higher unit costs for a like volume of production may be expected. Average costs for entire fiscal year 1935 probably will exceed those for the first 6 months.

ASPHALT AND RELATED BITUMENS[1]

By A. H. Redfield

SUMMARY OUTLINE

Production of petroleum asphalt and road oil and of native asphalt and bitumen increased from 1933 to 1934 due to revived demand for highway-construction materials and, to less extent, for roofing.

Refinery production of asphalt was 16 percent larger in 1934 than in 1933. Domestic demand, which normally accounts for nine tenths of the sales of petroleum asphalt, increased 12 percent in 1934 over that in 1933. Exports of petroleum asphalt were 10 percent larger in 1934 than in 1933; the chief gains were in exports to northern and western Europe and to the Far East. As a result of the greater increase in production than in demand stocks of petroleum asphalt held at refineries increased 23 percent at the end of 1934 over those at the end of 1933.

Although sales of paving asphalt were 16 percent larger in 1934 than in 1933 the increased activity in highway construction, due primarily to expenditure of Federal funds, was reflected chiefly in a 23-percent rise in sales of cut-back asphalts used to surface rural and secondary roads, especially west of the Mississippi River. Similarly, sales of road oil increased 23 percent, especially in western United States, and total sales of emulsified asphalts gained 24 percent. In Oklahoma a greater tonnage of natural rock asphalt sold in 1934 more than offset decreased sales in Kentucky, Alabama, and Texas.

Prices of both petroleum asphalt and road oil were higher in 1934 than in 1933. The average sales value of petroleum asphalt increased 13 percent and road oil 38 percent in 1934 over 1933 compared with an increase of 13.7 percent in the general level of wholesale prices.

[1] Figures on imports and exports compiled from records of the Bureau of Foreign and Domestic Commerce.

Salient statistics of asphalt and related bitumens in the United States, 1933–34

	1933	1934
SUPPLY		
Native asphalt and related bitumens:		
Produced short tons	313,135	440,852
Imported (chiefly lake asphalt) do	21,706	15,679
Petroleum asphalt (excluding road oil):		
Produced at refineries from—		
Domestic petroleum do	1,237,386	1,444,846
Foreign petroleum do	1,218,665	1,395,650
	2,456,051	2,840,496
Stocks, Jan. 1 do	298,684	276,363
Total supply do	3,089,576	3,573,390
DISTRIBUTION		
Native asphalt and related bitumens:		
Indicated domestic demand short tons	299,329	425,538
Exports (unmanufactured) do	13,806	15,314
Petroleum asphalt (excluding road oil):		
Indicated domestic demand (including lake asphalt) do	2,296,046	2,569,395
Exports do	204,032	223,906
Stocks, Dec. 31 do	276,363	339,237
Total distribution	3,089,576	3,573,390
VALUES		
Native asphalt and related bitumens:		
Sales	$1,705,310	$2,365,750
Imports (chiefly lake asphalt)	278,401	222,372
Exports (unmanufactured)	553,892	581,415
Petroleum asphalt:		
Sales (excluding road oil) from—		
Domestic petroleum	10,675,280	13,973,765
Foreign petroleum	12,867,264	15,921,674
Total sales	23,542,544	29,895,439
Exports	2,860,964	3,383,443

NATIVE ASPHALT AND BITUMENS

Bituminous rock.—Sales of natural rock asphalt increased from 285,070 short tons valued at $1,125,164 in 1933 to 410,453 tons valued at $1,762,376 in 1934. Of the 1934 production, 90,027 tons valued at $516,673 were sold by producers in Kentucky and Alabama and 290,940 tons valued at $1,152,331 by producers in Oklahoma, Texas and New Mexico.

The principal increase was in Oklahoma, where Federal allotments provided funds for road building and the policy of using hand labor wherever possible to spread employment favored the use of natural rock asphalt. On the other hand, sales of Texas rock asphalt decreased to a marked degree.

In the Southeastern and Gulf Coast States allotments of Federal money resulted in more mileage of road being built, but the tendency to use cheaper materials decreased sales of natural rock asphalt. Competition among producers resulted in price cutting during the latter part of 1934.

Gilsonite and wurtzilite.—Greater demand for paints and varnishes and greater activity in the electrical-equipment industry increased the sales of gilsonite by producers in northeastern Utah from 28,029 short tons valued at $577,716 in 1933 to 30,355 tons valued at $599,739 in 1934. Foreign sales of gilsonite increased during the first 8 months of 1934. During the last 4 months, however, exports to several European countries were curtailed by the system of "blocked" currencies.

Sales of wurtzilite increased from 36 tons valued at $2,430 in 1933 to 44 tons valued at $3,635 in 1934.

Exports.—Increased demand from South America raised exports of natural asphalt and bitumen, unmanufactured, from 13,806 short tons valued at $553,892 in 1933 to 15,314 tons valued at $581,415 in 1934.

Of the 1934 exports 72.5 percent went to Europe, chiefly to France, Germany, the United Kingdom, Belgium, Italy, and the Netherlands compared with 80.5 percent in 1933. Canada received 8.8 percent of the total in 1933 and 9.7 percent in 1934. South American countries, especially Brazil and Chile, which bought only 1.7 percent of the total in 1933, took 10.3 percent in 1934.

MANUFACTURED OR PETROLEUM ASPHALT

Domestic demand for petroleum asphalt increased 11.9 percent—from 2,296,046 short tons in 1933 to 2,569,395 tons in 1934. In response, refinery production of petroleum asphalt increased 15.7 percent—from 2,456,051 tons in 1933 to 2,840,496 tons in 1934. Exports of petroleum asphalt increased from 204,032 tons in 1933 to 223,906 tons in 1934. Imports, however, chiefly of lake asphalt and grahamite, decreased from 21,706 tons in 1933 to 15,679 tons in 1934. As production increased at a greater rate than demand (domestic and foreign) stocks of petroleum asphalt at refineries increased 62,874 tons during 1934 compared with a drop of 22,321 tons in 1933.

Production, receipts, stocks, consumption, transfers and losses, and sales of asphalt (exclusive of road oil) at petroleum refineries in the United States in 1934, by districts

District	Production	Other petroleum products blended	Receipts from other sources	Stocks	
				Dec. 31, 1933	Dec. 31, 1934
	Short tons	*Short tons*	*Short tons*	*Short tons*	*Short tons*
East Coast	1,201,772	58,844	8,202	96,254	99,667
Appalachian	108,569		43	9,028	11,114
Indiana-Illinois-Kentucky	452,010	17,528	3,763	57,447	82,580
Oklahoma-Kansas-Missouri	85,886	6,668	38	7,170	6,679
Texas:					
Gulf Coast	163,061			7,197	11,294
Rest of State	58,171			2,644	2,520
Total, Texas	221,232			9,841	13,814
Louisiana-Arkansas:					
Louisiana Gulf Coast	140,087	8,057		28,963	28,440
Northern Louisiana and Arkansas	139,147	5,805	2,196	19,169	44,622
Total, Louisiana and Arkansas	279,234	13,862	2,196	48,132	73,062
Rocky Mountain	30,207	2,581	9,832	2,525	5,328
California	327,882	34,221	41,078	45,966	46,993
Grand total, 1934	2,706,792	133,704	65,152	276,363	339,237
Total, 1933	2,319,479	136,572	53,955	298,684	276,363

Production, receipts, stocks, consumption, transfers and losses, and sales of asphalt (exclusive of road oil) at petroleum refineries in the United States in 1934, by districts—Continued

District	Consumption by companies	Transfers and losses	Sales	
			Quantity	Value
	Short tons	*Short tons*	*Short tons*	
East Coast	3,421		1,261,984	$14,579,080
Appalachian	201		106,325	1,453,479
Indiana-Illinois-Kentucky	2,603		445,565	4,661,921
Oklahoma-Kansas-Missouri	32,993		60,090	588,817
Texas:				
Gulf Coast	29,399	4,360	125,205	1,059,671
Rest of State			58,295	525,264
Total, Texas	29,399	4,360	183,500	1,584,935
Louisiana-Arkansas:				
Louisiana Gulf Coast	215	107	148,345	1,709,448
Northern Louisiana and Arkansas			121,695	887,213
Total, Louisiana and Arkansas	215	107	270,040	2,596,661
Rocky Mountain	461	7,443	31,913	396,957
California	30,643	3,687	367,824	4,033,589
Grand total, 1934	99,936	15,597	2,727,241	29,895,439
Total, 1933	89,646	17,881	2,424,800	23,542,544

Production.—A little less than half of the asphalt manufactured in petroleum refineries of the United States in 1934, as in 1933, was made from foreign crude oil imported from Venezuela, Mexico, and Colombia. The output of asphalt manufactured from foreign crude in refineries of the East Coast and Gulf Coast districts increased from 1,218,665 short tons in 1933 to 1,395,650 tons in 1934. Ninety-three percent of the asphalt manufactured in East Coast refineries in 1934 was made from foreign crude.

The total refinery output of asphalt in 1934 included 133,704 short tons of other petroleum products blended with the asphalt to produce commercial varieties of the proper hardness and consistency.

Sales by uses.—Sales of asphalt by petroleum refineries increased 12.5 percent in quantity—from 2,424,800 short tons in 1933 to 2,727,241 in 1934—and 27 percent in value—from $23,542,544 in 1933 to $29,895,439 in 1934. The average sales value per ton increased from $9.71 in 1933 to $10.96 in 1934.

Virtually all grades of asphalt sold at higher prices in 1934 than in 1933. The average sales value of paving asphalt at the refinery increased from $9.36 per short ton in 1933 to $10.77 in 1934, roofing asphalt from $9.68 to $10.76, cut-back asphalt from $11.34 to $12.06, paving flux from $7.89 to $10.22, and roofing flux from $7.49 to $7.52.

Asphalt and asphaltic material (exclusive of road oil) sold at petroleum refineries in the United States, in 1934, by varieties

[Value f.o.b. refinery]

	From domestic petroleum		From foreign petroleum		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Solid and semisolid products of less than 200 penetration: [1]						
Asphalt for:						
Paving	397,251	$4,061,467	526,884	$5,888,725	924,135	$9,950,192
Roofing	286,864	2,981,148	278,526	3,101,096	565,390	6,082,244
Waterproofing	50,870	534,494	47,039	541,054	97,909	1,075,548
Blending with rubber	1,234	18,833	15,372	195,506	16,606	214,339
Briquetting	33,435	372,649	4,109	40,054	37,544	412,703
Mastic and mastic cake	205	1,642	753	8,706	958	10,348
Pipe coatings	5,784	88,456	1,558	16,076	7,342	104,532
Molding compounds	4,983	62,012	6,137	74,332	11,120	136,344
Miscellaneous uses	39,162	451,430	35,490	427,629	74,652	879,059
Total	819,788	8,572,131	915,868	10,293,178	1,735,656	18,865,309
Semisolid and liquid products of more than 200 penetration: [1]						
Flux for—						
Paving	56,693	488,100	56,669	670,787	113,362	1,158,887
Roofing	144,648	909,456	41,752	491,362	186,400	1,400,818
Waterproofing	2,779	36,202	10,150	127,875	12,929	164,077
Mastic			197	2,500	197	2,500
Cut-back asphalts	298,154	3,490,325	326,029	4,034,840	624,183	7,525,165
Emulsified asphalts and fluxes	18,280	307,951	14,238	188,823	32,518	496,774
Paints, enamels, japans, and lacquers	7,214	102,499	6,965	90,832	14,179	193,331
Other liquid products	6,083	67,101	1,734	21,477	7,817	88,578
Total	533,851	5,401,634	457,734	5,628,496	991,585	11,030,130
Grand total, 1934	1,353,639	13,973,765	1,373,602	15,921,674	2,727,241	29,895,439
Total, 1933	1,192,707	10,675,280	1,232,093	12,867,264	2,424,800	23,542,544

[1] DEFINITIONS

Paving asphalt.—Refined asphalt and asphaltic cement, fluxed and unfluxed, produced for direct use in the construction of sheet asphalt, asphaltic concrete, asphalt macadam, and asphalt block pavements, and also for use as joint filler, in brick, block, and monolithic pavements.
Roofing asphalt.—Asphalt and asphaltic cement used in saturating, coating, and cementing felt or other fabric and in the manufacture of asphalt shingles.
Waterproofing asphalt.—Asphalt and asphaltic cement used to waterproof and dampproof tunnels, foundations of buildings, retaining walls, bridges, culverts, etc., and for constructing built-up roofs.
Briquetting asphalt.—Asphalt and asphaltic cement used to bind coal dust or coke breeze into briquets.
Mastic and mastic cake.—Asphalt and asphaltic cement for laying foot pavements and floors, waterproofing bridges, lining reservoirs and tanks, capable of being poured and smoothed by hand troweling.
Pipe coatings.—Asphalt and asphaltic cement used to protect metal pipes from corrosion.
Molding compounds.—Asphalts used in the preparation of molded composition, such as battery boxes, electrical fittings, push buttons, knobs, handles, etc.
Miscellaneous uses.—Asphalt and asphaltic cement used as dips, and in the manufacture of acid-resisting compounds, putty, saturated building paper, fiber board and floor coverings, and not included in the preceding definitions.
Flux.—Liquid asphaltic material used in softening native asphalt or solid petroleum asphalt for paving, roofing, waterproofing, and other purposes.
Cut-back asphalts.—Asphalts softened or liquefied by mixing them with petroleum distillates.
Emulsified asphalt and fluxes.—Asphalts and fluxes emulsified with water for cold-patching, road laying and other purposes.
Other liquid products.—Petroleum asphalt, exclusive of fuel oil used for heating purposes, not included in the preceding definitions.

More than three-fifths of the asphalt sold by petroleum refineries in 1934 was used for street and highway construction. Although contracts awarded for street and road construction covered only 5 percent more mileage in 1934 than in 1933 refinery sales of the grades of asphalt used for highway construction increased 16.7 percent from 1933 to 1934. The greatest increase was in sales of cut-back asphalts used for surfacing secondary highways—from 508,553 short tons in 1933 to 624,183 tons in 1934. Sales of emulsified asphalts by petroleum refineries decreased slightly—from 33,303 short tons (7,845,911 gallons) in 1933 to 32,518 tons (7,660,736 gallons) in 1934—but sales of emulsified asphalts manufactured by industrial companies from asphalts purchased from petroleum refineries increased from 24,149,000 gallons valued at $1,293,790 in 1933 (revised figures) to 31,963,798 gallons valued at $3,120,252 in 1934.

Refinery sales of paving asphalt used to pave city streets and hard-surfaced highways increased 15.7 percent—from 798,607 tons in 1933 to 924,135 tons in 1934. Sales of paving flux were slightly larger—113,362 tons in 1934 compared with 110,917 tons in 1933.

Increased road building and street paving in the Middle Atlantic States, the Southeastern States, and the Middle West were responsible for the principal increases in sales of paving asphalt in the East Coast district, the Appalachian district, the Indiana-Illinois-Kentucky district, the Louisiana Gulf Coast district, and northern and central Texas. On the other hand, decreased construction, especially of hard-surfaced highways, in the Pacific and Rocky Mountain States led to reduced sales of paving asphalt by California refineries.

The increases in sales of cut-back asphalts were confined almost entirely to districts west of the Mississippi River, especially the Oklahoma-Kansas-Missouri district, northern and central Texas, the Rocky Mountain district, and California.

Government funds financed the greater part of the highway construction in the United States during 1934. State highway funds were slightly higher in 1934 than in 1933, but the total remained far below the level of earlier years. In several States funds raised by taxes on sales of gasoline, hitherto devoted to road building and maintenance, were used partly for the relief of unemployment.

By the Hayden-Cartwright Act, approved June 18, 1934, Congress added $200,000,000 to the $400,000,000 previously allotted under the National Industrial Recovery Act of June 16, 1933, to road building and canceled State debts on Federal highway loans contracted during the fiscal years 1930 and 1931 to the amount of $200,000,000. The act provided, however, that any State would be deprived of one-third of its share of Federal-aid funds for highways if it diverted to other purposes funds raised by taxes on users of roads, thus reducing its contribution to the Federal-aid system of highways.

Of the $394,000,000 available under the National Industrial Recovery Act after 1½ percent was deducted for administrative expenses $251,788,000 was expended or allotted to the States for highway projects during the last 4 months of 1933, and an unexpended balance of $142,212,000 was available at the end of 1933 for new projects. The Hayden-Cartwright Act of June 18, 1934 added $200,000,000 to this amount. Allotments of Federal funds for road building during 1934 totaled $235,901,000 compared with $251,788,000 during 1933, leaving an unexpended balance of $106,311,000 available for new projects at the end of 1934.

During the last 4 months of 1933, 1,535.6 miles of Federal-aid highways were completed; 10,504.1 miles were under construction on December 31, 1933, and 5,607.3 miles had been approved for construction. During 1934, 18,690.5 miles were completed; 6,910.7 miles were under construction at the end of the year, and 3,319.7 miles had been approved for construction.

Fully two-thirds of the highways built with the aid of Federal funds during the 19 months ended March 31, 1935, consisted of light types of construction, such as untreated gravel and sand surfaces, or grading and draining operations. To afford maximum local employment, surfaces of the lower types were favored on the secondary or feeder roads where lighter traffic permitted.

Three-fifths of the mileage of the hard-surfaced types of construction, however, consisted of asphaltic types. Low-cost bituminous mixtures, used chiefly to surface rural highways and secondary or feeder roads, comprised one-half of the total of asphaltic surfaces laid. Fifty-six percent of the mileage of low-cost bituminous types of surface was laid west of the Mississippi River and Lake Michigan and 20 percent in the States east of the Mississippi River and south of the Ohio and Potomac Rivers. Asphaltic concrete comprised one-fourth of the total bituminous pavements. More than one-half of the asphaltic concrete was laid east of the Mississippi River and Lake Michigan, chiefly north of the Ohio and Potomac Rivers. Five-sixths of the bituminous macadam was laid east of the Mississippi River and Lake Michigan, especially in New England, New York, and Pennsylvania.

Twenty-nine percent of the asphalt sold by petroleum refineries in 1933 and 28 percent in 1934 was used for the manufacture of roofing. Although the apparent demand and production in the roofing industry, as measured by sales of prepared roofing and factory shipments of dry roofing felt, decreased slightly from 1933 to 1934 sales of roofing asphalt and flux increased from 702,090 short tons in 1933 to 751,790 tons in 1934. Gains in sales of asphalt for roofing purposes in Louisiana, Arkansas, Texas, and California, and smaller gains in the east coast district more than offset declines in the Illinois-Indiana-Kentucky district and the Oklahoma-Kansas-Missouri district.

Sales of asphalt used in building construction, in the form of waterproofing asphalt and flux, mastic and mastic flux, pipe coatings and paints, varnishes, and lacquers, increased slightly—from 132,859 tons in 1933 to 133,514 tons in 1934.

An increase in the production of coal briquets from 530,430 short tons in 1933 to 704,856 tons in 1934 was reflected in an increase in sales of briquetting asphalt from 31,090 tons in 1933 to 37,544 tons in 1934. The lower rate of increase in sales of briquetting asphalt may have been due to economies in the use of binders.[2]

Sales of asphalts—solid, semisolid, and liquid—for miscellaneous purposes increased from 76,732 tons in 1933 to 82,469 tons in 1934. Included in these unspecified uses of asphalt are the manufacture of expansion joints, sewer-pipe joinings, asphalt emulsions, saturated paper and cardboard for heat insulation, electric-cable coatings, and ink. A new use for asphalt was found in the construction of revetment mattresses to protect levees in flood-control work.

DOMESTIC DEMAND

The indicated domestic demand for petroleum asphalt (including small quantities of imported lake asphalt and grahamite) was 11.9 percent greater in 1934 than in 1933 and in 1932. It increased from 191,277 short tons a month in 1932 and 191,337 tons a month in 1933 to 214,116 tons a month in 1934.

[2] Further details in chapter on Fuel Briquets.

In terms of the long-time trend the indicated demand for asphalt was 23.5 percent below the expected demand for 1934 compared with 29.2 percent below the expected demand for 1933; that is, if the national demand for asphalt had continued the average rate of growth it manifested from 1908 to 1931 it would have averaged 260,423 tons a month in 1932, 270,246 tons a month in 1933, and 280,061 tons a month in 1934. Using these averages as a standard of comparison, the indicated demand of 191,337 tons a month in 1933 was 70.8 percent of the expected demand (270,246 tons) in 1933, and the indicated demand of 214,116 tons a month in 1934 was 76.5 percent of the expected demand (280,061 tons) in 1934.

The demand for asphalt is, however, seasonal to a marked degree, reaching its maximum in August and its minimum in February. Normally 62 percent of the refinery sales occur in the 6 months from

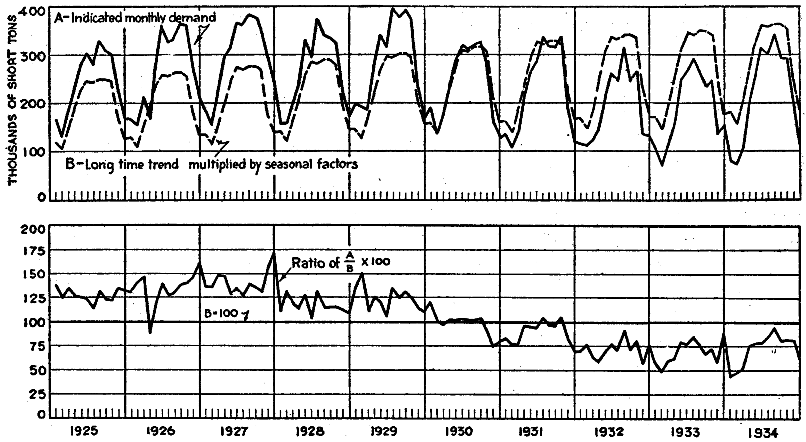

FIGURE 73.—Relation of indicated monthly demand for asphalt, 1925–34, to long-time trend, 1908–31, multiplied by seasonal factors. The long-time trend is expressed by the formula, log Y=1.095818+0.944148 log X, in which Y equals the average monthly demand for petroleum and lake asphalt during each year and X equals the number of years, beginning with 1907 as zero. The coefficient of correlation for this formula is 0.955. The seasonal factors were calculated for 1925–31 by the method of link relatives.

May 1 to October 31; from 1932 to 1934, 68 percent of the annual total was sold in these months. Consequently, to furnish an adequate standard of comparison, the monthly trend values are multiplied by a "seasonal factor" for each month.

Demand for asphalt was lowest in the first 3 months of 1934, averaging 48 percent of the long-time trend multiplied by seasonal factors compared with 56 percent in the first 3 months of 1933. In the second quarter of 1934 it made marked recovery, averaging 80 percent of the expected demand for those months compared with 72 percent during the second quarter of 1933. Demand was highest from July to September 1934, averaging 86 percent of the expected demand compared with 76 percent in the same months of 1933. Decreased demand in December 1934 brought down the average of the last 3 months of 1934 to 77 percent of the expected demand compared with 71 percent in the corresponding months of 1933.

Relation of indicated asphalt demand to basic trend multiplied by seasonal factors, 1933–34

Month	1933			1934		
	Trend multiplied by seasonal factors	Indicated monthly demand	Relation of indicated monthly demand to trend	Trend multiplied by seasonal factors	Indicated monthly demand	Relation of indicated monthly demand to trend
	Short tons	*Short tons*	*Percent*	*Short tons*	*Short tons*	*Percent*
January	172,816	103,183	59.71	180,633	79,668	44.10
February	148,504	71,873	48.40	154,976	74,098	47.81
March	196,501	116,549	59.31	204,741	105,912	51.73
April	257,019	159,034	61.88	267,377	201,766	75.46
May	316,073	249,577	78.96	328,299	253,525	77.22
June	348,029	265,924	76.41	360,942	314,410	87.11
July	343,978	290,612	84.49	356,795	301,841	84.60
August	351,370	266,359	75.81	363,296	341,563	94.02
September	351,255	235,150	66.95	362,628	291,937	80.51
October	343,518	247,597	72.08	354,105	291,560	82.34
November	239,275	136,897	57.21	246,279	199,613	81.05
December	178,088	153,291	86.08	183,028	113,502	62.01
		2,296,046			2,569,395	

DISTRIBUTION BY RAIL

The tonnage of asphalt (natural, byproduct, or petroleum) terminated by class I railroads in the United States increased 14.6 percent—from 2,407,553 short tons in 1933 to 2,757,897 tons in 1934—according to statistics of the Interstate Commerce Commission. The gains were general over the United States but were greater west of the Mississippi River and the Great Lakes, especially in the wheat- and corn-growing States west of the Lakes.

Sixty-three percent of the asphalt (petroleum, lake, and natural rock) terminated in the United States by land carriers in 1934 was delivered to consumers in the Northeastern district lying north of the Potomac and Ohio Rivers and east of the Mississippi and Illinois Rivers. Railroads terminated 1,726,803 short tons of asphalt in this district in 1933 and 1,897,239 tons in 1934. In the Southeastern district lying south of the Potomac and Ohio Rivers and east of the Mississippi and Pearl Rivers, railroad deliveries of asphalt increased from 278,499 tons in 1933 to 340,416 tons in 1934. In the Southwestern district west of the Mississippi and Pearl Rivers and south of St. Louis, Kansas City, and Amarillo, asphalt deliveries by land were 167,924 tons in 1933 and 175,973 tons in 1934. The greatest proportional gains were in the North Central district, where railroad terminations of asphalt increased from 116,208 tons in 1933 to 277,553 tons in 1934; and in the Pacific-Rocky Mountain district west of Great Falls, Cheyenne, Denver, Albuquerque, and El Paso, where the tonnage of asphalt terminated by land carriers increased from 188,346 tons in 1933 to 304,397 tons in 1934.

Supply and distribution of asphalt (petroleum, lake, and natural rock), exclusive of road oil in Continental United States, by districts, in 1934, in short tons

	North-eastern district	South-eastern district	South-western district	North Central district	Pacific-Rocky Mountain district
SOURCE					
Produced within district	1,597,790	330,960	885,662		466,936
Imported	12,053	2,520	1,014		39
Received by land carriers from:					
Northeastern district		25,000	3,000	80,000	
Southeastern district	357,174		30,000		
Southwestern district		363,076		172,615	
Pacific-Rocky Mountain district	25,000			25,000	
Received by water (coastwise, intraport, and river)	197,970	20,000	2,660		75,000
	2,189,987	741,556	922,336	277,615	541,975
DISTRIBUTION					
Shipped by land carriers:					
Within district	1,897,239	340,416	175,973	277,553	304,397
To Northeastern district		357,174			25,000
To Southeastern district	25,000		363,076		
To Southwestern district	3,000	30,000			
To North Central district	80,000		172,615		25,000
Shipped by water (coastwise, intraport, and river)	111,000	10,000	84,630		90,000
Exported	47,870	212	97,630	62	92,748
Added to stocks	25,878	3,754	28,412		4,830
	2,189,987	741,556	922,336	277,615	541,975

FOREIGN TRADE

Imports.—Imports of asphalt and bitumen, unmanufactured, decreased from 21,706 short tons valued at $278,401 in 1933 to 15,679 tons valued at $222,372 in 1934. Of the 1934 imports 9,606 tons valued at $108,442 consisted of lake asphalt from Trinidad and 5,861 tons valued at $99,042 grahamite or glance pitch from Cuba. Atlantic coast ports received 14,220 tons valued at $189,840 and Gulf coast ports 1,014 tons valued at $17,923.

Exports.—Increased demand from countries of northern and western Europe and from the Far East was chiefly responsible for a rise of 9.7 percent in exports of petroleum asphalt from 204,032 short tons in 1933 to 223,906 tons in 1934. However, sales of petroleum asphalt to northern and western Europe in 1934 were less than half as large as in 1930, and the growth of petroleum refining in the United Kingdom, France, Germany, and the Netherlands casts doubt on the possibilities of future expansion of this trade. Moreover, shipments of asphalt from Mexico to Europe increased from 76,000 short tons in 1933 to 131,000 tons in 1934. In the Far East increased purchases of petroleum asphalt from the United States by Netherland East Indies, French Indo-China, New Zealand, Hong Kong, Japan, and the Philippine Islands more than compensated for decreased purchases by China and Australia. In the Mediterranean region Italy and Spain increased their imports of asphalt from the United States. Increased exports to British Malaya, Ceylon, and Mozambique in the Indian Ocean region counteracted a decrease in sales to British India.

Petroleum asphalt exported from the United States, 1932–34, by countries

Country	1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	12,168	$131,287	3,492	$67,665	2,937	$63,113
Other North America	1,988	36,419	5,461	91,884	6,927	109,509
	14,156	167,706	8,953	159,549	9,864	172,622
South America:						
Argentina	671	15,686	5,900	89,300	2,120	40,729
Brazil	1,129	15,559	2,233	35,077	3,713	64,970
Other South America	1,070	16,022	3,200	51,111	2,599	42,159
	2,870	47,267	11,333	175,488	8,432	147,858
Europe:						
Belgium	3,131	47,585	3,778	56,775	4,183	66,578
Denmark	316	3,084	121	3,253	1,781	30,356
France	21,542	295,293	11,160	153,225	14,815	217,956
Germany	3,680	60,266	4,880	79,837	5,031	89,599
Italy	27,887	399,896	26,863	331,491	28,765	417,273
Netherlands	3,368	65,598	6,656	98,026	7,136	120,091
Spain	2,910	39,995	4,595	60,802	4,819	65,981
United Kingdom	11,763	235,211	17,141	334,145	22,107	461,624
Other Europe	2,639	44,860	3,239	47,883	4,511	80,291
	77,236	1,191,788	78,433	1,165,437	93,148	1,549,749
Asia:						
Ceylon	1,966	27,814	5,141	69,004	6,788	76,210
China	9,312	165,221	5,367	77,734	3,816	59,695
East Indies:						
British:						
India	10,734	147,959	13,635	174,473	7,984	123,082
Malaya	4,395	78,663	5,441	78,579	7,566	114,403
Netherland	15,999	244,314	18,586	204,518	24,012	284,354
French Indo-China	12,170	219,994	2,572	40,870	3,612	48,306
Hong Kong	1,887	32,160	2,347	35,402	3,276	51,967
Japan	6,652	117,969	3,704	59,380	4,003	61,705
Philippine Islands	10,178	147,293	9,368	94,683	9,989	108,736
Other Asia	1,343	23,209	1,999	37,801	142	2,646
	74,636	1,204,596	68,160	872,444	71,188	931,104
Africa:						
Algeria and Tunisia	1,698	24,989			42	659
Mozambique	214	4,132	1,422	22,863	5,526	85,518
Union of South Africa	5,771	93,387	8,117	132,470	7,541	118,555
Other Africa	28	1,006	739	14,802	1,436	28,114
	7,711	123,514	10,278	170,135	14,545	232,846
Oceania:						
Australia	27,841	411,065	24,965	293,596	23,065	298,678
New Zealand	1,533	21,862	1,821	22,950	3,505	48,438
Other British	23	340	89	1,365	159	2,148
	29,397	433,267	26,875	317,911	26,729	349,264
	206,006	3,168,138	204,032	2,860,964	223,906	3,383,443

ROAD OIL

Increased construction of secondary and farm-to-market roads financed largely by Federal funds increased sales of road oil more than one-fifth, or from 6,238,898 barrels valued at $6,289,119 in 1933 to 7,702,753 barrels valued at $10,741,998 in 1934. The gains were general, except in the Appalachian district, but were greatest in the Rocky Mountain district, the California district, the Oklahoma-Kansas-Missouri district, and the Indiana-Illinois-Kentucky district. Increased demand stimulated prices of road oil; the average value of road oil sold at petroleum refineries in the United States was $1.01 in 1933 and $1.39 in 1934.

Road oil sold by petroleum refineries in the United States, 1933–34, by districts

District	1933		1934	
	Barrels	Value	Barrels	Value
East coast	863,656	$1,243,813	938,053	$1,392,665
Appalachian	137,868	222,770	88,195	186,298
Indiana-Illinois-Kentucky	1,828,844	1,666,754	1,984,414	2,390,175
Oklahoma-Kansas-Missouri	661,953	597,792	942,072	1,071,260
Texas:				
Gulf coast	165,141	199,619	204,888	274,188
Rest of State	61,826	38,691	79,969	79,963
Total Texas	226,967	238,310	284,857	354,151
Louisiana-Arkansas:				
Louisiana Gulf coast	48,814	68,469	52,464	95,089
Northern Louisiana and Arkansas	101,241	63,865	157,992	158,104
Total Louisiana and Arkansas	150,055	132,334	210,456	253,193
Rocky Mountain	484,505	531,582	1,023,434	1,431,920
California	1,885,050	1,655,764	2,231,272	3,662,336
Grand total	6,238,898	6,289,119	7,702,753	10,741,998

Of the road oil sold in the United States in 1934, only 788,919 barrels valued at $1,302,377 were made from foreign petroleum, imported from Venezuela and Mexico. Of the road oil made from foreign crude, 88 percent was sold by refineries of the Atlantic seaboard in 1933 and 87.5 percent in 1934; the remainder was made in Gulf coast refineries of Louisiana and Texas.

Eighty-four percent of the road oil sold in 1933 and 79 percent of that sold in 1934 came from four refining districts—the East coast district, the Indiana-Illinois-Kentucky district, the Oklahoma-Kansas-Missouri district and the California district. Sales in the Rocky Mountain district increased from 7.8 percent of the national total in 1933 to 13.3 percent in 1934.

Petroleum refineries in the United States reported the production of 6,210,390 barrels of road oil in 1934 compared with 5,534,455 barrels in 1933. The refinery output of road oil was augmented in 1934 by 1,456,354 barrels of other petroleum products, chiefly fuel oil, transferred to road-oil stocks compared with 1,027,814 barrels similarly transferred in 1933. Stocks of road oil and of transferred fuel and other oils held at refineries in the United States decreased from 832,738 barrels on December 31, 1933, to 663,847 barrels on December 31, 1934. Consumption of road oil at refineries in their own operations, transfers, losses, and adjustments took 132,882 barrels during 1934 compared with 61,966 barrels in 1933.

Prices of road oil in all districts were higher in 1934 than in 1933. In the East coast district the average sales value of road oil increased from $1.44 per barrel in 1933 to $1.48 in 1934, in the Indiana-Illinois-Kentucky district from $0.91 to $1.20, in the Oklahoma-Kansas-Missouri district from $0.90 to $1.14, in the Rocky Mountain district from $1.10 to $1.40, and in California from $0.88 to $1.64.

CEMENT [1]

By H. H. Hughes, B. W. Bagley, and E. T. Shuey

SUMMARY OUTLINE

The increase in construction contracts awarded in 1934 compared with 1933 was reflected in a moderate upturn in cement shipments, despite continued low levels of residential building and concrete paving. Production of cement during 1934 exceeded shipments, resulting in increased stocks. A sharp upturn in average value, combined with the increase in shipments, accounted for the greatest total value of cement shipments since 1931. Salient statistics of the industry in 1933 and 1934 are summarized in the following table.

Salient statistics of the cement industry in the United States, 1933–34

	1933	1934 [1]	Percent of change in 1934
Portland cement:			
Production ... barrels	63,473,189	77,682,000	+22
Shipments ... do	64,282,756	75,917,000	+18
Stocks at mills [2] ... do	19,541,491	21,460,000	+10
Capacity ... do	269,387,000	(3)	
Value of shipments	$85,600,717	$115,771,000	+35
Unit factory value	$1.33	$1.52	+14
Exports: [4]			
Barrels	680,307	566,462	−17
Total value	$1,487,707	$1,334,046	−10
Average per barrel [5]	$2.19	$2.36	+8
Imports for consumption:			
Barrels	477,193	265,999	−44
Total value	$400,153	$264,416	−34
Business indicators:			
Capacity utilized:			
Portland cement [6] ... percent	23.6	29.0	+23
Steel [7] ... do	34.0	37.0	+9
Industrial production [8] ... index numbers	76.0	79.0	+4
Asphalt, domestic demand [9] ... short tons	2,296,046	2,569,365	+12

[1] Subject to revision.
[2] End of year.
[3] Total capacity figure for 1934 not yet computed.
[4] Excludes shipments to Alaska, Hawaii, and Puerto Rico—265,598 barrels in 1933 and 487,174 barrels in 1934.
[5] Value of exports is actual cost at time of exportation in ports of the United States, as declared by shippers on export declarations.
[6] Output of finished cement is compared with estimated capacity of 163 plants at end of December 1933 and 162 plants at end of December 1934.
[7] Computed from statistics of the Iron and Steel Institute.
[8] Federal Reserve Board; 1923–25 average=100.
[9] Compiled by A. H. Redfield, Bureau of Mines; petroleum asphalt only.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

According to preliminary figures summarized from monthly statements, actual shipments of cement totaled 75,917,000 barrels in 1934. Although this represents an increase of 18 percent from 1933, shipments were far below the yearly average of the past 25 years. Production in 1934 was 77,682,000 barrels, 1,765,000 barrels more than shipments. Stocks at mills increased from 19,541,491 barrels at the end of 1933 to 21,460,000 barrels at the end of 1934.

The sharp decline in quantity and value of portland cement shipments since 1928 was arrested in 1934, but the totals were far below 1928 (see fig. 74). The upturn in shipments was accompanied by an increase in stocks, with no appreciable change in capacity.

The upward trend in cement prices continued in 1934; the average factory value advanced 14 percent—from $1.33 in 1933 to $1.52 in 1934. The total value of the cement shipped from mills increased 35 percent—from $85,600,717 in 1933 to $115,771,000 in 1934. This higher net realization improved the financial position of producers, although it is estimated that the cement industry as a whole operated during 1934 at only 29 percent of capacity.

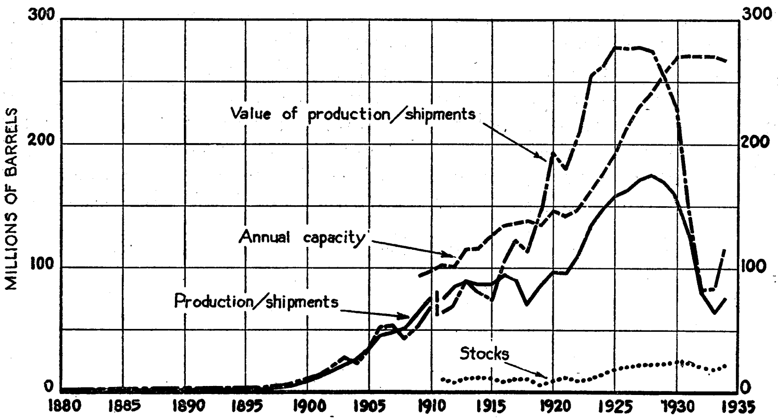

FIGURE 74.—Principal trends in the portland-cement industry, 1880–1934. Production and value of production are shown from 1880 to 1910; shipments and value of shipments from 1911 to 1934.

To gain a proper perspective of the cement industry its statistics must be compared with those of other industries. Production of steel ingots during 1934 was maintained at 37 percent of capacity compared with 34 percent in 1933. The indicated domestic demand for asphalt in 1934 increased 12 percent over 1933. Asphalt is used chiefly for paving and roofing. Shipments of prepared roofing in 1934 were 2 percent less than in 1933, thus indicating that activity in bituminous paving was responsible for the increased demand for asphalt.

Index numbers of the Federal Reserve Board, computed to show industrial production compared with the 1923–25 average as 100, stood at 79 in 1934, a net gain of 3 points and equivalent to a rise of 4 percent from 76, the average level of the index in 1933.

The Federal Reserve Board also computes a monthly index of cement production adjusted for seasonal variation. These data are plotted with the adjusted index of industrial production in figure 75. The position of the curves indicates that the cement industry held up well during 1930 and most of 1931 but dropped far below the general level of business from 1932 through 1934.

Operation under the code.—Operations of the cement industry throughout 1934 were governed by the Code of Fair Competition for the Cement Industry, which went into effect December 7, 1933. Although there was some criticism of the code by individuals in the industry, as well as others, and although complaints of noncompliance were received, cement producers generally seemed in favor of the code after a year's operation under its provisions.

Controversy regarding the code centered around the selling-methods provisions, which in general continued the long-established practice of marketing cement through dealers. Numerous exceptions were made, however, and immediately after the code went into effect building-supply dealers protested against curtailment of their activities. A hearing was held January 15, 1934, but differences of opinion could not be settled, and on January 23 the Administrator

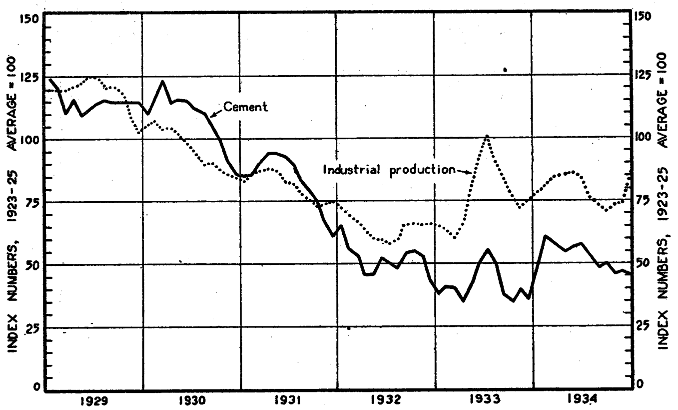

FIGURE 75.—Cement production compared with industrial production, 1929-34. The cement industry was relatively active through 1931 but dropped below industrial production from 1932 through 1934. The data are compiled by the Federal Reserve Board, and both indexes have been adjusted for seasonal variation.

ordered the selling-methods provisions suspended until an agreement could be reached.

An amendment to replace the controversial section of the code was presented at a public hearing July 11.[2] Apparently it represented a compromise between the cement industry and the building-supply dealers, but it met with strenuous objections from the ready-mixed concrete and contractor groups. Additional amendments proposed at the same hearing by the labor, consumer, and legal representatives of the N. R. A. were not acceptable to the industry. Apparently no agreement was reached, as no substitute for the original selling-methods provisions had been adopted at the end of the year.

At times the public hearings assumed somewhat the nature of an open forum for presentation of information regarding such problems as obsolescence, capitalization, marketing practices, and capacity.[3]

Increase in employment.—Employment in the cement industry increased 20 percent in 1934 compared with 1933, according to the

[2] Pit and Quarry, Proposed Code Changes Disturb Cement Makers: Vol. 27, no. 2, August 1934, pp. 23–24.

[3] Rock Products, Cement Code Amendments Subject of Debate at Hearing: Vol. 37, no. 8, August 1934, pp. 28–30.

index of employment compiled by the Bureau of Labor Statistics (see fig. 76). This index, on the basis of the 1923–25 average as 100, stood at 41.1 in 1933 and 49.3 in 1934. For comparison the 1934 indexes of other industries in the stone, clay, and glass-products group were as follows: Glass, 89.8; pottery, 69; marble, granite, slate, and other products, 30.7; and brick, tile, and terra cotta, 29.7.

Employment in virtually all other industries was maintained during 1934 at a level considerably higher than cement. For example, the index for the iron and steel group was 69; machinery, 77.7; transportation equipment, 82.9; nonferrous metals, 74.3; textiles, 91.2; leather, 87.8; food, 106.5; tobacco, 62.6; paper and printing, 94.9; chemicals, 108.6; and rubber, 82.9. The index was 48.7 for lumber and allied products, the only industrial group with an index below 52.8, the figure for the stone, clay, and glass-products group. The general index of employment for all industry was 78.8 in 1934, compared with 69 in 1933 and a low of 64.1 in 1932.

Since 1930 the index of pay rolls in the cement industry, as in other industries, has been substantially lower than the index of employ-

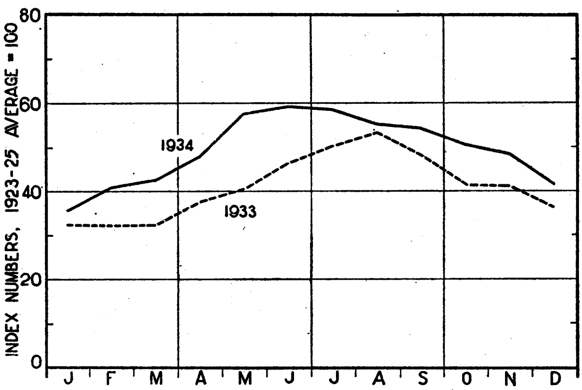

FIGURE 76.—Employment in the cement industry, 1933–34, by months. Data plotted are index numbers compiled by the Bureau of Labor Statistics on the basis of the 1923–25 average as 100.

ment; in 1934 the two indexes were 30.6 and 49.3, respectively. This variation reflects efforts to employ more men through "spread-work" movements or through labor provisions of the code. The 36-hour week and in many mills the 6-hour day have become well established in the cement industry.

Wage rates in general have been maintained at higher levels than the mandatory regional minimums of 30 to 40 cents an hour. According to supplementary data compiled by the Bureau of Labor Statistics the average hourly earnings per man in 1934 ranged from 53.6 cents in March to 57.8 cents in August. The average work week ranged from 30.3 hours in December to 35.6 hours in June.

The trend toward shorter hours in the cement industry apparently has been accompanied by increased efficiency in plant operation, as a drop of 23 percent in average length of shift—from 9.5 hours in 1928 to 7.3 hours in 1933—was accompanied by a decline of only 5 percent in average output per man-shift. The average production per man-hour increased from 1.63 barrels in 1928 to 2.07 barrels in 1931, then slumped to 2.01 barrels in 1933. This represented a net advance of

23 percent from 1928 to 1933 in average output of cement per man-hour of employment. Detailed statistics of employment correlated with production records are presented in a later section of this chapter.

Consumption by States.—Cement shipments in the United States increased 18 percent in 1934 compared with 1933, the rate of change ranging from a decline of 16 percent into Maine to an advance of 113 percent into Arizona. Except for Maine and the District of Columbia declines were confined to States in the Mississippi Valley, including Missouri, Oklahoma, Illinois, Mississippi, and Kentucky.

In comparing shipments during 1933 and 1934 it must be remembered that cement consumption during 1933 reached extraordinarily low levels and that, even with increases of 50 to 100 percent in 1934, shipments into most States remained far below those in peak years.

Shipments into Montana, Arizona, and Nevada increased more than 100 percent. In general, shipments into States of large consumption

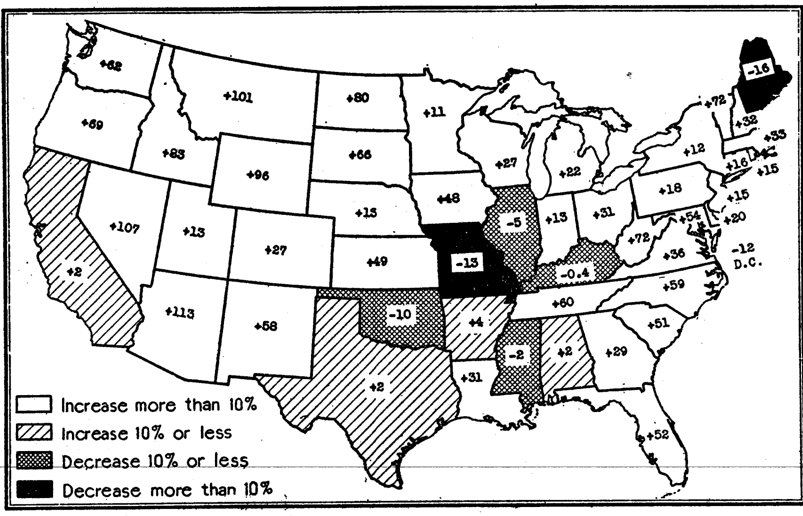

FIGURE 77.—Shipments of cement into States in 1934 compared with 1933. Figures represent percentage change in 1934.

showed moderate increases as follows: New York, 12 percent; California, 2 percent; Pennsylvania, 18 percent; Ohio, 31 percent; Texas, 2 percent; and Michigan, 22 percent. Shipments into Illinois, however, dropped 5 percent.

Figure 77 compares shipments into States in 1934 with those in 1933. Figures on States represent percentage change in 1934.

Prices.—Since 1900 the price level of portland cement in general has been slightly lower than the composite of all building materials, according to price indexes of the Bureau of Labor Statistics. Even during the peak of 1920 the index number of cement prices remained relatively low, rising to only 117.2 compared with 150.1 for building materials and 154.4 for all commodities.

Detailed price fluctuations are plotted in figure 78. The dotted curve represents the weighted index of 86 price series covering all building materials, as compiled by the Bureau of Labor Statistics. Data for the solid curve showing monthly fluctuation in cement prices are compiled also by the Bureau of Labor Statistics by averaging quotations, f. o. b. plant, at six plants in the United States. The average annual factory value of cement is computed by the Bureau of Mines from reports of producers, who are requested to report the total selling value of their product, f. o. b. plant. Further instructions are given manufacturers to exclude the price of containers and to make proper adjustments for cash discounts allowed. To permit ready comparison with Bureau of Labor Statistics data, the figures on unit factory value are also shown as index numbers with the value for 1926 taken as 100.

The sharp increase in cement prices during the latter half of 1933 continued in January 1934 with the index rising to 93.9, and except for a brief slump in April and May the index remained at that level throughout the year. The composite price, from which the index number of 93.9 was calculated, was $1.65 a barrel, f. o. b. plants.

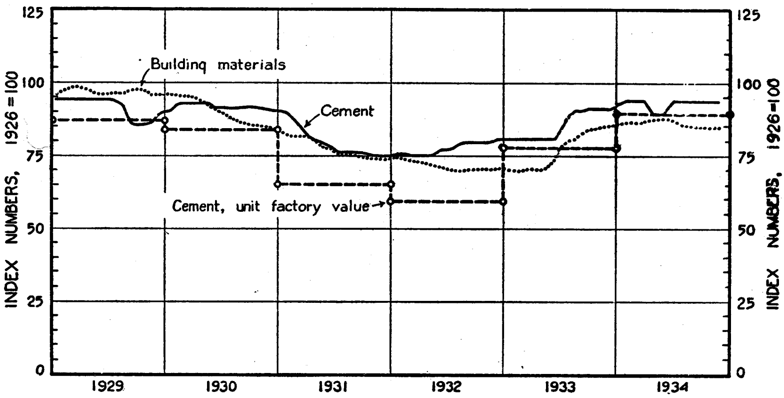

FIGURE 78.—Trends in prices of portland cement compared with a weighted price of all building materials, 1929–34. The solid curve "Cement" is plotted from index numbers compiled by the Bureau of Labor Statistics from quoted prices, f. o. b. plant. The curve "Cement, unit factory value" represents national average prices actually received by manufacturers as reported by them to the Bureau of Mines.

The price index of all building materials increased gradually throughout the first 6 months of 1934, reaching a peak of 87.8 in June, but dropped toward the end of the year. The average level of the index for the last 5 months was only a little above 85.

The average factory value of portland cement as reported to the Bureau of Mines is an accurate indicator of net realization by producers. The relatively low level of this figure during 1931 and 1932 compared with preceding and succeeding years indicates that sales were made throughout this period at prices far below current quotations. In 1932 the difference between the average factory value of $1.01 a barrel and the Bureau of Labor Statistics composite price of $1.35 a barrel was $0.34; the comparable figure in 1934 was only $0.11, the difference between $1.52 and $1.63.

Despite the sharp rise during 1933 and early 1934, prices of cement and building materials in general remained substantially below the 1926 level.

PRINCIPAL MARKETS [4]

The portland-cement industry depends directly upon construction for its markets. Concrete in highways and structural concrete in buildings consume more than half the output of cement in an average year. The remainder also enters some form of construction through miscellaneous jobs on farms, sidewalks, concrete products, railway maintenance, waterworks, bridges, river and harbor improvements, and dams, or in other engineering projects. An adequate review of conditions in the cement industry during 1934, therefore, should include a brief discussion of the construction industry, statistics of which are summarized in the accompanying table.

Construction contracts.—Total construction contracts awarded during 1934 increased 23 percent from 1933, according to statistics of the F. W. Dodge Corporation. Despite this increase, the total of $1,543,842,000 was less than one-fourth of the total awards in 1928. Contracts awarded for public works, public utilities, and nonresidential projects increased 25, 22, and 34 percent, respectively;

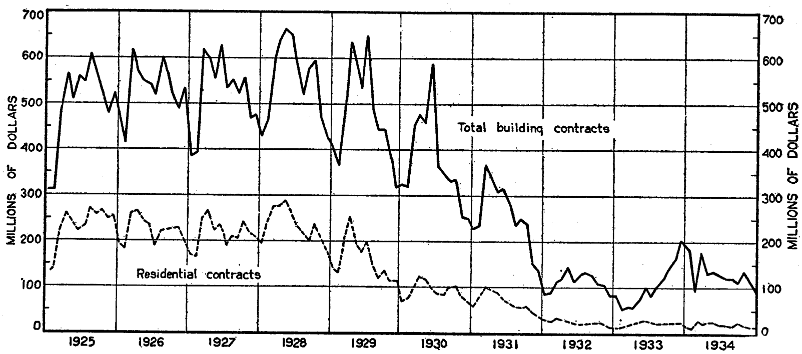

FIGURE 79.—Construction contracts awarded, 1925–34, by months. The general decline in contract awards during 1934 and the continued low level of residential contracts are conspicuous. Data are from reports of the F. W. Dodge Corporation.

but residential contracts remained virtually unchanged, dropping less than 1 percent from 1933. The volume of residential construction, as indicated by square feet of contracts awarded, fell 9 percent in 1934 compared with 1933.

Total construction contracts and residential contracts awarded from 1925 to 1934 are shown graphically in figure 79. The general low level of construction since 1931 is in striking contrast to that in earlier years, and the decline throughout 1934 contrasts sharply with the advance late in 1933. The unbroken low level of residential contracts since 1931 is especially noteworthy.

Building permits.—Figures on building permits issued in 819 cities during 1934, collected by the Bureau of Labor Statistics, also show that residential construction continued to drop during the year. The total value of permits issued in 1934 was 6 percent higher than in 1933. This increase, however, was due to an advance of 29 percent in permits for additions, alterations, and repairs; permits for residential structures decreased 13 percent and those for nonresidential buildings increased only 1 percent.

[4] Detailed discussion of construction statistics is contained in Minerals Yearbook, 1934, p. 787.

Public buildings.—The Bureau of Labor Statistics also compiles data on contracts awarded by States and by the Federal Government. Since October 1933 P. W. A. contracts have been included.

Contracts for Federal buildings in 1934, including P. W. A. projects, were 11 percent less than in 1933, but awards for State buildings increased 26 percent. Both the Federal building total of $76,028,264 and the State building total of $38,515,764 were overshadowed by non-Federal P. W. A. building projects amounting to $170,382,545.

Engineering construction.—The Engineering News-Record collects statistics covering construction of dams, reservoirs, levees, bridges, docks, and other engineering projects which provide important outlets for cement. Total engineering construction contract awards in 1934 amounted to $1,360,596,000, an increase of 27 percent from 1933.

Included among contracts awarded in 1934 as part of the P. W. A. program were railroad construction and repair projects totaling $198,181,141; river and harbor projects, $133,399,194; water and sewerage projects, $104,597,042; and reclamation projects, $86,866,129.

Highway construction.—The cement industry depends upon concrete paving for much of its business. According to data compiled by the Portland Cement Association concrete pavement contracts awarded in 1934 totaled virtually the same as in 1933. Awards for roads only, however, dropped 19 percent.

Summary of statistics of the construction industry in the United States, 1933–34 [1]

Type of construction	1933	1934 [2]	Percent of change in 1934
Construction contracts awarded:[3]			
Total value	$1,256,601,000	$1,543,842,000	+22.9
Public works	$499,518,000	$625,046,000	+25.1
Public utilities	$103,203,000	$126,193,000	+22.3
Nonresidential	$404,564,000	$543,705,000	+34.4
Residential	$249,314,000	$248,898,000	−.2
Residential, floor space ... square feet	72,796,000	66,325,000	−8.9
Building permits issued:[4]			
Total value [5]	$467,056,621	$492,630,536	+5.5
Nonresidential	$212,863,492	$215,778,941	+1.4
Residential	$123,686,772	$107,941,581	−12.7
Additions, alterations, and repairs	$130,506,357	$168,910,014	+29.4
Public building contracts awarded:[4]			
Federal buildings [6]	$85,403,832	$76,028,264	−11.0
State buildings	$30,619,678	$38,515,764	+25.8
Non-Federal buildings, P. W. A.	[7] $23,701,467	$170,382,545	
Engineering construction:[4]			
Total contracts awarded [8]	$1,068,369,000	$1,360,596,000	+27.4
River and harbor projects, P. W. A.	[9] $112,760,074	$133,399,194	
Reclamation projects, P. W. A.	[9] $7,906,186	$86,866,129	
Water and sewerage projects, P. W. A.[10]	[9] $29,912,153	$104,597,042	
Railroad construction and repair, P. W. A.	(11)	$198,181,141	
Concrete pavement contracts awarded:[12]			
Total ... square yards	45,128,000	45,108,000	−.04
Roads only ... do	37,138,000	30,203,000	−18.7
Highway construction contracts awarded:[4]			
Public roads [13]	[9] $165,687,072	$271,923,304	
Streets and roads, Federal, P. W. A.[14]	[9] $20,595,434	$14,653,603	
Streets and roads, non-Federal, P. W. A.[14]	[7] $8,726,129	$50,243,342	
State highways	$62,203,192	$80,573,556	+29.5

1 Comparable figures for 1928 are given in Minerals Yearbook, 1934, p. 788.
2 Subject to revision.
3 F. W. Dodge Corporation.
4 Bureau of Labor Statistics, except as otherwise noted.
5 Building permit figures cover 819 cities.
6 Includes P. W. A. (beginning October 1933) and other Federal contracts.
7 3 months only, October–December 1933.
8 Engineering News-Record.
9 4 months only, September–December 1933.
10 Includes both Federal and non-Federal projects.
11 Comparable data not available.
12 Portland Cement Association.
13 P. W. A. and other Federal funds administered by Bureau of Public Roads.
14 Street and road projects other than those of the Bureau of Public Roads.

Figure 80 shows concrete paving awards and cement shipments from 1925 to 1934. In complete absence of the customary spring peak, 1933 and 1934 contrast sharply with the earlier years.

Data are available also to show total public roads contracts, Federal and non-Federal P. W. A. street and road contracts, and State highway contracts. For 1934 these awards totaled $417,393,805, but it must be remembered that all types of highway construction are included.

Miscellaneous outlets for cement.—No estimate of cement consumption on farms is available, but the index of purchasing power of farmers indicates the general trend. In 1933, on the basis of the 1910–14 average as 100, the revised index of the Bureau of Agricultural Economics was 64, whereas in 1934 it had risen to 74. Although the index registered an appreciable gain in 1934 it is still below the 1928 level of 96.

No accurate estimates of output of concrete products have been published since 1930. The continued slump in residential construction indicates that at best such output in 1934 was only 5 to 10 percent higher than in 1933. This conclusion is substantiated by an increase of 7 percent in shipments of face brick, which follow the same general trend as production of concrete building units.

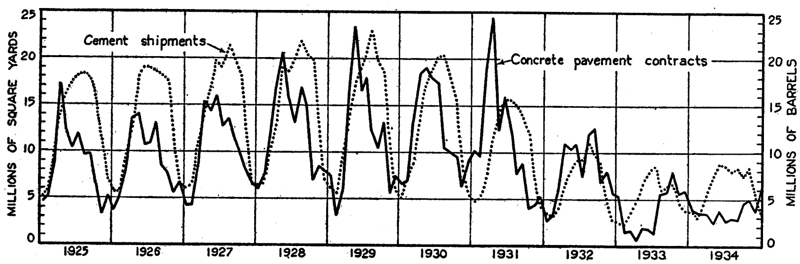

FIGURE 80.—Concrete pavement contract awards and cement shipments, 1925–34. The contrast between awards in the spring months of 1933 and 1934 and comparable periods of earlier years stands out sharply. Data on contracts are from the Portland Cement Association.

TRENDS IN EMPLOYMENT AND OUTPUT PER MAN [5]

Although cement production declined in 1933 to the lowest level in 25 years, the total number of wage earners in the cement industry increased from 1932 to 1933 as a result of the general adoption throughout the industry of the 36-hour week and 6-hour shift. Actual man-hours worked, however, dropped sharply, and the output of cement per man-hour of employment in 1933 was virtually unchanged from 1932.

Lack of adequate statistics to show relationships between employment and production has hampered studies of economic problems in various branches of the mineral industry. Data on productivity of labor in coal mining and iron-ore mining are available, but for other mineral products only miscellaneous bits of information have been collected. For several years the cement industry, cooperating in a program of accident prevention, has reported employment statistics to the Bureau of Mines. In collaboration with W. W. Adams, chief statistician of the Demographical Division, the employment

[5] Statistics on employment and output per man presented in this discussion were compiled by E. T. Shuey from records of the Demographical Division, Bureau of Mines.

record for the 6-year period, 1928–33, has been correlated with statistics of production. Data on employment in the Bureau files show separately quarry, crusher, mill, and miscellaneous employees. Mill employees at an average cement plant outnumber quarry and crusher employees more than 4 to 1.

The study covers 129 plants representing about nine-tenths of the total production of finished cement; exact coverage ranged from 87.3 percent in 1930 to 89.0 percent in 1933 and 89.1 percent in 1928 and 1929. The total number of plants that reported production ranged from 143 in 1933 to 163 in 1929.

The following discussion and tables summarizing the results of this study illustrate the sharp effect of the depression on operating activity and employment in the cement industry and present for the first time data that should be given careful consideration in connection with any labor provisions that affect the industry.

Estimated total employment.—Estimates of total men employed and total man-hours of employment in the cement industry, 1928–33, are summarized in the following table. They are based on the assumption that conditions of employment in the rest of the industry were the same as in the plants covered by the detailed study. Employment declined from an estimated total of more than 35,000 in 1928 to less than 20,000 in 1932, then increased to about 22,000 in 1933.

For 1929 and 1931 these estimates check closely the totals reported by the Bureau of the Census. In 1933, however, the Bureau of Mines figure shows an increase from 1932 in number of men employed, whereas the Bureau of the Census figure is considerably lower. This apparent discrepancy in the two figures reflects the difference in statistical procedure employed. The Bureau of Mines asks for the average number of men employed at each mill during the actual period of operation; for example, a plant employing 200 men may operate only 60 days during the year, but the entire 200 men are included in the total employment figure. The Bureau of the Census, on the other hand, averages monthly totals of employment to arrive at an average for the year. The Bureau of Mines figure, therefore, shows the number of men actually employed by the cement industry during the year, even though some may have worked only a short period, whereas the Bureau of the Census figure represents more closely the number of men to whom the industry could have provided full-time employment throughout the year.

The average employee included in the Bureau of Mines estimated total for 1933 worked 7.3 hours a day for 196 days. The estimated total man-hours of employment was 31,500,000, a decline of 18 percent from the estimate for 1932. This drop in man-hours of employment is comparable with the decline based on the average number of men employed in 1933 as reported by the Bureau of the Census.

Estimated total employment in the cement industry in the United States, 1928–33

Year	Included in detailed study			Estimated total	
	Employees	Man-hours	Percent of total finished cement	Employees	Man-hours
1928	31,295	96,541,428	89.1	35,100	108,300,000
1929 [1]	29,274	88,528,269	89.1	32,900	99,300,000
1930	27,775	78,771,352	87.3	31,800	90,300,000
1931 [1]	22,036	53,833,283	88.9	24,800	60,500,000
1932	17,440	33,799,409	87.9	19,800	38,500,000
1933 [1]	19,536	28,048,172	89.0	22,000	31,500,000

[1] Bureau of the Census reported 33,368 wage earners in the cement industry in 1929, 24,317 in 1931, and 15,829 in 1933.

Output per man.—In 1928, the peak year of cement production, 31,295 men worked a total of 10,137,187 man-shifts and 96,541,428 man-hours, an average of 9.5 hours per man per day for 324 days. These employees accounted for a production of 157,121,800 barrels of finished cement, an average of 15.50 barrels per man-shift and 1.63 barrels per man-hour. In 1933, employment totaled 19,536 men, a drop of 38 percent from 1928, but the average man worked only 196 days a year and 7.3 hours a day. Total man-shifts and man-hours therefore fell 62 and 71 percent, respectively, from 1928. The average length of shift dropped 23 percent, from 9.5 hours in 1928 to 7.3 hours in 1933, but the output per man-shift declined only 5 percent. During the same time the average output per man-hour increased 23 percent, from 1.63 barrels in 1928 to 2.01 barrels in 1933.

Employment in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33

Year	Employment					Production			Percent of industry represented [1]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1928	31,295	324	10,137,187	9.5	96,541,428	157,121,800	15.50	1.63	89.1
1929	29,274	319	9,345,890	9.5	88,528,269	152,116,204	16.28	1.72	89.1
1930	27,775	308	8,562,897	9.2	78,771,352	140,771,728	16.44	1.79	87.3
1931	22,036	279	6,146,564	8.8	53,833,283	111,501,887	18.14	2.07	88.9
1932	17,440	231	4,020,861	8.4	33,799,409	67,449,096	16.77	2.00	87.9
1933	19,536	196	3,835,657	7.3	28,048,172	56,463,620	14.72	2.01	89.0

[1] Calculated for each year by dividing the quantity of finished cement produced at mills included in study by the total production.

From 1928 to 1933 the general decline in man-hours of employment was slightly greater than the drop in production because of the increase in output of cement per man-hour worked (see fig. 81). This increase in productivity of labor reflects improved technic and increased efficiency of operation. The actual output per man-hour reached a peak of 2.07 barrels in 1931, then slumped slightly in 1932 and 1933. Efforts to maintain employment through reduction in length of the workweek and workday are shown by the increase from 1932 to 1933 in the number of men employed.

Mill employees.—In 1928 the average mill employee worked 9.5 hours a day for 332 days and produced 1.98 barrels of finished cement per hour; in 1933 he worked only 7.3 hours a day for 206 days but produced 2.50 barrels of cement per hour. Despite the shorter shift,

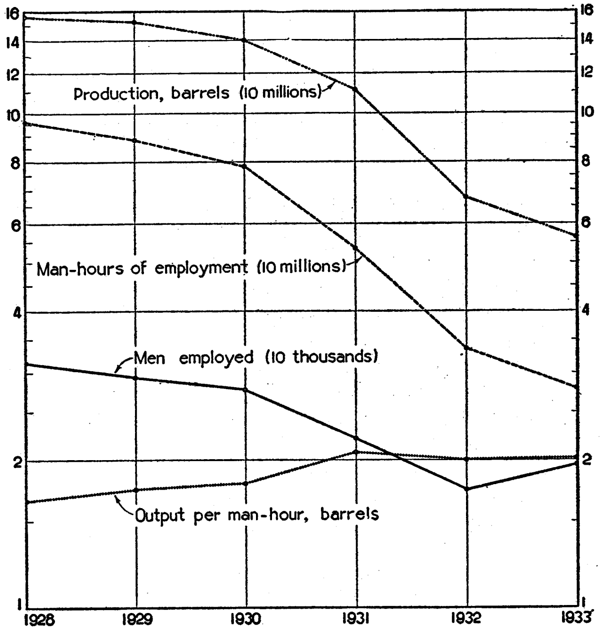

FIGURE 81.—Trends in employment in the cement industry, production of cement, and output per man-hour in the United States, 1928–33. Data are plotted on a logarithmic scale to show percentage-change relationships in their proper perspective.

the average output of 18.19 barrels per man-shift in 1933 was only slightly less than the corresponding output of 18.82 barrels in 1928.

Mill employees in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33

Year	Employment—cement mill only					Production			Percent of industry represented [1]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1928	25, 122	332	8, 346, 570	9. 5	79, 226, 232	157, 121, 800	18. 82	1. 98	89. 1
1929	23, 755	328	7, 791, 270	9. 4	73, 405, 571	152, 116, 204	19. 52	2. 07	89. 1
1930	22, 271	320	7, 132, 322	9. 2	65, 524, 129	140, 771, 728	19. 74	2. 15	87. 3
1931	17, 309	294	5, 086, 328	8. 7	44, 502, 808	111, 387, 566	21. 90	2. 50	88. 8
1932	13, 551	243	3, 290, 962	8. 4	27, 563, 197	67, 402, 383	20. 48	2. 45	87. 8
1933	15, 075	206	3, 103, 654	7. 3	22, 592, 150	56, 454, 620	18. 19	2. 50	88. 9

[1] Calculated for each year by dividing the quantity of finished cement produced at mills included in study by the total production.

Quarry and crusher employees.—Data on tonnage of quarry rock and overburden handled by quarry and crusher employees are available for most cement plants, beginning with 1929. The average quantity of material handled per man-hour of employment increased from 3.20 short tons in 1929 to 4.01 tons in 1931, then slumped to 3.47 tons in 1933. The percentage of overburden included in the total material handled declined steadily from 15.3 percent in 1929 to 7.5 percent in 1933. Curtailment of quarry development work in advance of actual operations during the depression may account for the drop in relative quantity of overburden handled.

Quarry and crusher employees in the cement industry, material (quarry rock and overburden) handled at quarries included in study, and average output of material per man in the United States, 1929–33

Year	Employment—quarry and crusher only					Material handled—quarry rock and overburden				Percent of industry represented [1]
	Average number of men	Time employed				Short tons	Percent of overburden included	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours				Per shift	Per hour	
				Average per man per day	Total					
1929	5,123	281	1,441,964	9.6	13,779,252	44,113,986	15.3	30.59	3.20	78.1
1930	4,939	256	1,264,000	9.1	11,536,403	40,413,300	13.4	31.97	3.50	76.3
1931	4,141	225	929,924	8.8	8,221,384	32,991,564	10.0	35.48	4.01	82.1
1932	3,480	185	643,113	8.6	5,505,342	19,662,583	7.8	30.57	3.57	83.2
1933	3,954	165	651,458	7.4	4,827,640	16,741,818	7.5	25.70	3.47	83.7

[1] Calculated for each year by dividing the quantity of finished cement produced at mills included in study by the total production.

Hours per day.—From 1928 to 1933 there was a definite trend toward shorter hours. In 1933 more than half of the labor force worked less than 8 hours a day and 93 percent less than 9 hours. In 1928 and 1929, however, no employees worked less than 8 hours a day, and in 1928, 39 percent of the total worked 10 hours a day or longer. (See fig. 82.)

Number of men employed in the cement industry in the United States and output per man-hour, 1928–33, classified according to hours of labor per day

Hours per day	1928			1929			1930		
	Men employed		Production per man-hour (barrels)	Men employed		Production per man-hour (barrels)	Men employed		Production per man-hour (barrels)
	Number	Percent of total		Number	Percent of total		Number	Percent of total	
Less than 7							129	0.5	2.07
7 and less than 8							389	1.4	3.55
8 and less than 9	13,205	42.2	1.80	14,504	49.6	1.91	13,785	49.6	1.85
9 and less than 10	5,924	18.9	1.70	3,873	13.2	1.91	5,809	20.9	1.89
10 and less than 11	4,851	15.5	1.52	4,896	16.7	1.51	3,430	12.4	1.71
11 and less than 12	7,167	22.9	1.43	5,731	19.6	1.46	4,233	15.2	1.49
More than 12	148	.5	1.43	270	.9	1.70			
	31,295	100.0	1.63	29,274	100.0	1.72	27,775	100.0	1.79

Number of men employed in the cement industry in the United States and output per man-hour, 1928–33, classified according to hours of labor per day—Contd.

Hours per day	1931			1932			1933		
	Men employed		Production per man-hour (barrels)	Men employed		Production per man-hour (barrels)	Men employed		Production per man-hour (barrels)
	Number	Percent of total		Number	Percent of total		Number	Percent of total	
Less than 7	113	0.5	2.12	1,320	7.6	1.97	6,802	34.8	2.25
7 and less than 8	894	4.0	2.05	1,907	10.9	2.27	4,467	22.9	2.06
8 and less than 9	14,633	66.4	2.19	9,946	57.0	2.03	6,875	35.2	1.89
9 and less than 10	477	2.2	2.10	1,946	11.2	2.14	1,006	5.1	1.65
10 and less than 11	3,698	16.8	1.86	1,467	8.4	1.66	215	1.1	1.63
11 and less than 12	2,133	9.7	1.78	854	4.9	1.43	171	.9	.83
More than 12	88	.4	1.29						
	22,036	100.0	2.07	17,440	100.0	2.00	19,536	100.0	2.01

In general, throughout the period from 1928 to 1933 the output of cement per man-hour worked was higher for employees working

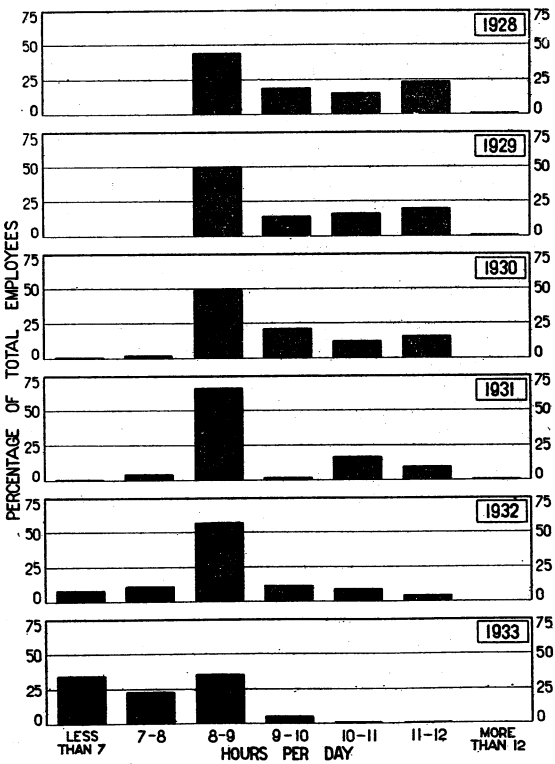

FIGURE 82.—Employment in the cement industry classified according to hours of labor per day, 1928–33.

short shifts than for those working longer hours. In 1933, for example, the group of employees (35 percent of the total) who worked less than 7 hours daily produced 2.25 barrels of cement per man-hour; 23 percent, who worked 7 to 8 hours, produced 2.06 barrels per man-hour; and 35 percent, who worked 8 to 9 hours, produced only 1.89 barrels per man-hour. Further declines are shown by employees working longer than 9 hours, but the number of men in each group is too small to be representative of the cement industry as a whole.

It should be pointed out, however, that nothing is known regarding the relative efficiency of the plants represented by the various groups of employees. If the plants working short hours are generally more efficient than the average, the output per man-hour naturally would be relatively high. Further study is necessary to clarify the relationship between hours of employment and output per man.

District and State tables.—The following tables show a geographic break-down by districts and States of the statistical record of employment and productivity of labor in the cement industry. These data are primarily of interest in the study of regional relationships.

Employment in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33, by districts and by States

District, State, and year	Employment					Production			Percent of industry represented [1]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
DISTRICT									
1. Eastern Pennsylvania, New Jersey, and Maryland:									
1928	6,964	335	2,333,618	10.0	23,340,328	37,572,007	16.10	1.61	94.7
1929	6,635	333	2,211,810	9.8	21,639,689	35,832,198	16.20	1.66	95.0
1930	6,066	324	1,966,013	9.3	18,232,377	33,118,286	16.85	1.82	94.2
1931	5,093	301	1,534,759	8.9	13,652,340	27,335,649	17.81	2.00	95.4
1932	4,230	232	983,259	8.5	8,384,773	15,193,137	15.45	1.81	93.8
1933	4,232	192	810,864	7.3	5,888,523	11,159,670	13.76	1.90	94.5
2. New York and Maine:									
1928	2,011	336	675,915	9.5	6,449,064	10,680,136	15.80	1.66	93.0
1929	2,000	334	667,439	9.3	6,215,135	10,756,324	16.12	1.73	94.2
1930	2,213	326	721,490	9.2	6,626,619	10,461,663	14.50	1.58	92.2
1931	1,930	311	599,482	9.0	5,394,048	9,899,602	16.51	1.84	96.0
1932	1,692	265	449,047	8.2	3,676,220	6,606,288	14.71	1.80	99.9
1933	1,627	211	342,722	7.0	2,400,422	4,500,813	13.13	1.88	98.3
3. Ohio, western Pennsylvania, and West Virginia:									
1928	3,539	298	1,055,545	9.4	9,921,535	15,269,375	14.47	1.54	83.3
1929	3,077	299	918,549	9.5	8,731,281	14,507,630	15.79	1.66	80.9
1930	2,815	274	771,339	9.1	7,033,118	14,073,122	18.25	2.00	79.9
1931	2,317	221	511,809	8.2	4,196,816	9,110,344	17.80	2.17	78.8
1932	1,740	208	361,751	8.0	2,897,139	5,401,695	14.93	1.86	80.7
1933	2,095	163	341,905	7.7	2,646,628	4,407,467	12.89	1.67	82.7
4. Michigan:									
1928	1,093	325	355,102	9.9	3,522,829	7,187,868	20.24	2.04	51.9
1929	1,120	331	370,503	10.1	3,733,433	7,487,262	20.21	2.01	54.5
1930	976	314	306,716	9.8	3,000,761	6,558,223	21.38	2.19	57.0
1931	708	244	172,949	8.6	1,492,945	3,917,619	22.65	2.62	63.9
1932	483	265	128,049	9.2	1,179,471	2,341,946	18.29	1.99	54.5
1933	523	214	112,085	8.1	911,228	2,042,933	18.23	2.24	56.2
5. Wisconsin, Illinois, Indiana, and Kentucky:									
1928	4,926	335	1,651,501	8.6	14,278,337	22,381,123	13.55	1.57	98.4
1929	4,313	323	1,394,677	8.5	11,886,612	21,198,351	15.20	1.78	99.2
1930	3,897	312	1,215,052	8.4	10,221,660	19,883,327	16.36	1.95	98.3
1931	2,979	275	818,896	8.5	6,971,859	15,059,750	18.39	2.16	99.2
1932	2,193	245	536,992	7.8	4,196,323	10,541,507	19.63	2.51	99.3
1933	2,478	200	496,033	7.1	3,524,942	7,908,137	15.94	2.24	100.0

[1] Calculated for each year by dividing the quantity of finished cement produced at mills included in study by the total production.

Employment in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33, by districts and by States—Continued

District, State, and year	Employment					Production			Percent of industry represented
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
DISTRICT—contd.									
6. Virginia, Tennessee, Alabama, Georgia, Florida, and Louisiana:									
1928	2,990	308	921,609	10.2	9,432,007	15,587,878	16.91	1.65	97.7
1929	2,674	304	813,835	9.9	8,032,192	13,203,349	16.22	1.64	95.7
1930	2,363	297	701,783	9.8	6,871,572	12,028,463	17.14	1.75	93.4
1931	2,207	276	608,191	9.1	5,560,292	11,468,582	18.86	2.06	93.2
1932	2,005	160	320,078	9.2	2,935,468	5,198,495	16.24	1.77	92.9
1933	1,976	183	362,008	7.4	2,694,893	5,352,185	14.78	1.99	94.4
7. Eastern Missouri, Iowa, Minnesota, and South Dakota:									
1928	3,160	310	978,290	9.7	9,511,554	15,163,067	15.50	1.59	90.8
1929	2,899	312	905,218	9.9	8,962,754	14,333,187	15.83	1.60	91.3
1930	3,015	317	954,893	9.5	9,034,368	14,767,776	15.47	1.63	88.5
1931	2,186	278	607,365	9.2	5,607,542	11,372,825	18.72	2.03	87.7
1932	1,466	262	384,503	9.3	3,590,022	7,776,281	20.22	2.17	86.4
1933	2,439	192	468,951	7.0	3,269,082	6,607,574	14.09	2.02	90.3
8. Western Missouri, Nebraska, Kansas, Oklahoma, and Arkansas:									
1928	2,263	324	733,214	9.7	7,121,464	10,389,510	14.17	1.46	95.0
1929	2,071	322	666,151	9.6	6,382,872	11,717,219	17.59	1.84	94.5
1930	2,108	320	674,014	9.4	6,356,660	11,085,474	16.45	1.74	88.6
1931	1,374	276	379,654	8.2	3,129,885	7,830,530	20.63	2.50	85.3
1932	1,023	224	229,308	8.0	1,840,425	4,216,138	18.39	2.29	74.6
1933	1,130	229	258,357	7.2	1,850,076	4,164,205	16.12	2.25	84.4
9. Texas:									
1928	852	347	295,336	11.0	3,245,232	5,254,896	17.79	1.62	82.8
1929	1,060	322	341,264	10.8	3,702,592	6,572,232	19.26	1.78	89.1
1930	1,273	287	365,376	10.2	3,736,585	5,185,762	14.19	1.39	76.5
1931	974	289	281,420	9.5	2,668,811	4,829,076	17.16	1.81	78.0
1932	745	248	184,756	8.5	1,566,311	3,246,404	17.57	2.07	86.6
1933	857	175	149,980	8.3	1,241,334	2,671,577	17.81	2.15	89.9
10. Colorado, Montana, Utah, Wyoming, and Idaho:									
1928	523	268	140,300	8.2	1,154,000	2,195,000	15.65	1.90	79.2
1929	489	243	118,818	8.4	1,000,210	1,746,759	14.70	1.75	64.8
1930	481	214	102,996	8.7	895,185	1,538,208	14.93	1.72	67.8
1931	358	212	75,734	8.6	653,150	1,571,760	20.75	2.41	70.9
1932	322	194	62,351	8.0	498,921	1,013,850	16.26	2.03	79.8
1933	256	205	52,539	8.0	420,301	797,254	15.17	1.90	64.1
11. California:									
1928	2,107	355	747,024	8.4	6,284,164	12,003,129	16.07	1.91	88.5
1929	2,060	339	698,485	8.6	5,980,697	11,962,447	17.13	2.00	91.4
1930	1,713	319	546,396	8.4	4,588,880	8,529,165	15.61	1.86	84.2
1931	1,273	303	385,810	8.2	3,148,875	6,399,020	16.59	2.03	82.7
1932	1,066	281	299,857	8.0	2,387,956	4,569,080	15.24	1.91	83.3
1933	1,399	275	384,978	7.3	2,816,327	6,096,513	15.84	2.16	85.1
12. Oregon and Washington:									
1928	867	288	249,733	8.0	1,998,714	3,437,811	13.77	1.72	86.8
1929	876	273	239,141	8.1	1,935,562	2,799,246	11.71	1.45	82.5
1930	855	277	236,829	8.1	1,907,662	3,542,259	14.96	1.86	86.6
1931	637	268	170,495	8.0	1,356,720	2,707,130	15.88	2.00	90.0
1932	475	170	80,910	8.0	646,380	1,344,275	16.61	2.08	84.9
1933	524	105	55,235	7.0	384,416	755,092	13.67	1.96	83.2

Employment in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33, by districts and by States—Continued

District, State, and year	Employment					Production			Percent of industry represented
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
STATE [2]									
Alabama:									
1928	976	308	300, 360	10. 7	3, 228, 038	6, 749, 202	22. 47	2. 09	100. 0
1929	871	299	260, 164	9. 9	2, 567, 386	[3] 5, 241, 356	20. 15	2. 04	[3] 104. 7
1930	816	305	248, 687	9. 9	2, 463, 595	4, 821, 141	19. 39	1. 96	100. 0
1931	798	258	205, 637	9. 3	1, 906, 194	4, 446, 902	21. 63	2. 33	100. 0
1932	722	102	73, 891	9. 6	708, 644	1, 453, 374	19. 67	2. 05	100. 0
1933	601	192	115, 401	7. 3	838, 149	1, 968, 513	17. 06	2. 35	100. 0
Illinois:									
1928	1, 498	350	524, 723	8. 5	4, 449, 182	7, 334, 833	13. 98	1. 65	100. 0
1929	1, 572	329	517, 816	8. 7	4, 529, 544	8, 242, 725	15. 92	1. 82	100. 0
1930	1, 352	317	429, 149	8. 6	3, 685, 768	7, 934, 563	18. 49	2. 15	100. 0
1931	1, 134	273	309, 317	8. 5	2, 617, 076	6, 407, 191	20. 71	2. 45	100. 0
1932	890	269	239, 616	7. 6	1, 832, 740	5, 480, 813	22. 87	2. 99	100. 0
1933	1, 213	197	238, 687	6. 8	1, 633, 140	3, 973, 853	16. 65	2. 43	100. 0
Iowa:									
1928	1, 177	305	358, 581	11. 3	4, 040, 648	5, 514, 030	15. 38	1. 36	80. 0
1929	1, 066	312	332, 333	11. 1	3, 678, 788	4, 975, 233	14. 97	1. 35	78. 1
1930	1, 144	333	381, 281	10. 7	4, 087, 378	5, 333, 779	13. 99	1. 30	75. 2
1931	865	265	229, 333	10. 5	2, 414, 036	4, 260, 853	18. 58	1. 77	73. 4
1932	733	229	167, 520	10. 8	1, 808, 952	3, 078, 819	18. 38	1. 70	72. 1
1933	1, 045	149	155, 501	7. 7	1, 196, 010	2, 351, 922	15. 12	1. 97	77. 3
Kansas:									
1928	1, 421	311	441, 514	8. 7	3, 833, 384	6, 574, 219	14. 89	1. 72	100. 0
1929	1, 209	314	380, 020	8. 6	3, 267, 089	[3] 6, 965, 344	18. 32	2. 13	[3] 103. 3
1930	1, 202	303	364, 222	8. 4	3, 067, 034	6, 012, 360	16. 51	1. 96	100. 0
1931	833	272	226, 782	8. 3	1, 891, 994	4, 145, 195	18. 28	2. 19	100. 0
1932	502	214	107, 303	8. 3	893, 253	2, 295, 541	21. 39	2. 57	100. 0
1933	594	220	130, 659	7. 4	963, 066	2, 201, 182	16. 85	2. 29	100. 0
Missouri:									
1928	1, 624	315	512, 207	8. 9	4, 540, 799	7, 358, 504	14. 37	1. 62	93. 4
1929	1, 511	313	473, 379	9. 4	4, 438, 618	7, 373, 068	15. 58	1. 66	90. 9
1930	1, 496	303	453, 276	8. 7	3, 927, 056	6, 864, 618	15. 14	1. 75	87. 9
1931	986	281	276, 938	8. 6	2, 383, 434	5, 125, 394	18. 51	2. 15	90. 4
1932	477	311	148, 236	8. 3	1, 230, 760	3, 335, 105	22. 50	2. 71	78. 7
1933	1, 198	222	265, 812	6. 4	1, 699, 565	3, 500, 568	13. 17	2. 06	92. 2
New York:									
1928	1, 912	341	651, 090	9. 5	6, 161, 614	10, 156, 286	15. 60	1. 65	92. 7
1929	1, 829	332	606, 488	9. 2	5, 559, 266	10, 099, 096	16. 65	1. 82	93. 8
1930	2, 031	323	656, 074	9. 1	5, 977, 859	9, 492, 681	14. 47	1. 59	91. 5
1931	1, 768	306	540, 352	8. 9	4, 795, 448	9, 076, 813	16. 80	1. 89	95. 7
1932	1, 582	263	416, 825	8. 2	3, 414, 608	6, 006, 874	14. 41	1. 76	99. 9
1933	1, 483	214	317, 536	7. 0	2, 228, 177	4, 124, 892	12. 99	1. 85	98. 1
Ohio:									
1928	1, 458	303	441, 587	9. 2	4, 056, 611	6, 410, 097	14. 52	1. 58	69. 4
1929	1, 214	311	377, 862	9. 2	3, 490, 560	6, 624, 718	17. 53	1. 90	70. 3
1930	1, 039	285	295, 932	9. 5	2, 807, 935	6, 191, 515	20. 92	2. 21	71. 7
1931	991	248	245, 726	8. 3	2, 044, 450	4, 702, 285	19. 14	2. 30	77. 5
1932	929	195	181, 190	8. 3	1, 511, 705	3, 218, 511	17. 76	2. 13	80. 4
1933	920	172	158, 666	7. 9	1, 247, 407	2, 272, 778	14. 32	1. 82	81. 7
Pennsylvania:									
1928	7, 220	331	2, 387, 251	9. 7	23, 258, 226	39, 417, 398	16. 51	1. 69	94. 9
1929	6, 936	331	2, 292, 602	9. 6	22, 074, 203	37, 205, 351	16. 23	1. 69	94. 5
1930	6, 365	321	2, 044, 700	9. 2	18, 725, 321	35, 078, 404	17. 16	1. 87	92. 7
1931	5, 088	284	1, 443, 421	8. 7	12, 561, 691	26, 453, 821	18. 33	2. 11	92. 8
1932	3, 710	248	920, 016	8. 3	7, 662, 975	14, 450, 358	15. 71	1. 89	91. 5
1933	4, 271	186	794, 451	7. 2	5, 715, 369	11, 374, 925	14. 32	1. 99	92. 5
Tennessee:									
1928	827	310	256, 757	9. 6	2, 477, 391	4, 328, 044	16. 86	1. 75	92. 3
1929	603	297	179, 281	9. 7	1, 734, 609	3, 617, 591	20. 18	2. 09	81. 4
1930	597	269	160, 794	9. 5	1, 532, 107	3, 022, 194	18. 80	1. 97	78. 0
1931	533	244	129, 854	8. 9	1, 149, 768	2, 464, 438	18. 98	2. 14	74. 6
1932	440	123	54, 167	9. 0	485, 053	1, 148, 210	21. 20	2. 37	74. 2
1933	404	168	67, 705	8. 0	540, 504	1, 030, 216	15. 22	1. 91	76. 5

[2] Michigan, Texas, and California listed as districts 4, 9, and 11, respectively; separate data not available for States other than those shown.
[3] Includes small quantity of special cements, figures for which cannot be separated from those for standard portland.

Mill employees in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33, by districts and by States

District, State, and year	Employment—cement mill only					Production			Percent of industry represented[1]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
DISTRICT									
1. Eastern Pennsylvania, New Jersey, and Maryland:									
1928	5,945	342	2,034,027	10.0	20,352,240	37,572,007	18.47	1.85	94.7
1929	5,775	340	1,960,730	9.8	19,230,981	35,832,198	18.27	1.86	95.0
1930	5,152	334	1,719,948	9.3	15,938,536	33,118,286	19.26	2.08	94.2
1931	4,180	312	1,303,961	8.9	11,560,951	27,335,649	20.96	2.36	95.4
1932	3,459	243	841,448	8.4	7,073,386	15,193,137	18.06	2.15	93.8
1933	3,423	196	670,965	7.3	4,907,677	11,159,670	16.63	2.27	94.5
2. New York and Maine:									
1928	1,624	346	561,699	9.5	5,347,080	10,680,136	19.01	2.00	93.0
1929	1,675	345	577,986	9.3	5,362,148	10,756,324	18.61	2.01	94.2
1930	1,818	337	612,609	9.2	5,629,769	10,461,663	17.08	1.86	92.2
1931	1,551	322	498,888	9.0	4,475,096	9,899,602	19.84	2.21	96.0
1932	1,364	280	381,596	8.0	3,067,938	6,606,288	17.31	2.15	99.9
1933	1,258	231	290,332	6.9	2,009,002	4,500,813	15.50	2.24	98.3
3. Ohio, western Pennsylvania, and West Virginia:									
1928	2,372	316	749,790	9.3	6,961,581	15,269,375	20.36	2.19	83.3
1929	2,040	314	640,870	9.4	6,015,304	14,507,630	22.64	2.41	80.9
1930	2,024	292	591,381	9.2	5,414,154	14,073,122	23.80	2.60	79.9
1931	1,616	243	392,217	8.1	3,173,292	9,110,344	23.23	2.87	78.8
1932	1,245	220	273,627	8.0	2,185,151	5,376,371	19.65	2.46	80.3
1933	1,463	174	254,108	7.7	1,954,978	4,407,667	17.35	2.25	82.7
4. Michigan:									
1928	960	339	325,874	9.9	3,219,242	7,187,868	22.06	2.23	51.9
1929	995	340	337,915	10.0	3,391,593	7,487,262	22.16	2.21	54.5
1930	839	319	267,963	9.8	2,613,231	6,558,223	24.47	2.51	57.0
1931	589	258	151,760	8.6	1,311,996	3,917,619	25.81	2.99	63.9
1932	377	288	108,549	9.3	1,006,217	2,341,946	21.58	2.33	54.5
1933	382	232	88,703	8.0	709,621	2,042,933	23.03	2.88	56.2
5. Wisconsin, Illinois, Indiana, and Kentucky:									
1928	4,339	342	1,483,262	8.6	12,814,684	22,381,123	15.09	1.75	98.4
1929	3,773	329	1,241,107	8.5	10,577,836	21,198,351	17.08	2.00	99.2
1930	3,388	320	1,085,275	8.4	9,133,588	19,883,327	18.32	2.18	98.3
1931	2,484	284	705,548	8.6	6,036,114	15,059,750	21.34	2.49	99.2
1932	1,781	243	433,511	7.8	3,379,105	10,520,825	24.27	3.11	99.1
1933	1,989	209	415,203	7.2	2,968,946	7,908,137	19.05	2.66	100.0
6. Virginia, Tennessee, Alabama, Georgia, Florida, and Louisiana:									
1928	2,198	315	691,947	10.3	7,143,859	15,587,878	22.53	2.18	97.7
1929	2,130	312	664,818	9.9	6,554,740	13,203,349	19.86	2.01	95.7
1930	1,679	318	533,540	9.8	5,239,413	12,028,463	22.54	2.30	93.4
1931	1,586	297	471,328	10.1	4,768,678	11,468,582	24.33	2.40	93.2
1932	1,413	178	251,819	9.2	2,315,868	5,198,495	20.64	2.24	92.9
1933	1,397	209	291,294	7.2	2,094,183	5,352,185	18.37	2.56	94.4
7. Eastern Missouri, Iowa, Minnesota, and South Dakota:									
1928	2,459	310	761,977	9.7	7,356,771	15,163,067	19.90	2.06	90.8
1929	2,308	319	736,724	9.6	7,087,977	14,333,187	19.46	2.02	91.3
1930	2,369	327	775,440	9.5	7,355,044	14,767,776	19.04	2.01	88.5
1931	1,727	297	513,558	9.3	4,768,678	11,372,825	22.15	2.38	87.7
1932	1,154	271	313,268	9.4	2,955,815	7,776,281	24.82	2.63	86.4
1933	1,884	194	365,629	7.0	2,548,743	6,607,574	18.07	2.59	90.3

[1] Calculated for each year by dividing the quantity of finished cement produced at mills included in study by the total production.

Mill employees in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33, by districts and by States—Continued

District, State, and year	Employment—cement mill only					Production			Percent of industry represented
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours					
				Average per man per day	Total		Per shift	Per hour	
DISTRICT—contd.									
8. Western Missouri, Nebraska, Kansas, Oklahoma, and Arkansas:									
1928	1,852	329	609,876	9.8	5,947,187	10,389,510	17.04	1.75	95.0
1929	1,665	329	547,558	9.6	5,267,410	11,717,219	21.40	2.22	94.5
1930	1,729	327	564,847	9.5	5,359,851	11,085,474	19.63	2.07	88.6
1931	1,091	291	317,411	8.3	2,620,014	7,716,209	24.31	2.95	84.0
1932	837	234	195,906	8.1	1,588,754	4,216,138	21.52	2.65	74.6
1933	919	240	220,778	7.1	1,573,690	4,164,205	18.86	2.65	84.4
9. Texas:									
1928	665	352	234,306	11.4	2,672,112	5,254,896	22.43	1.97	82.8
1929	839	330	276,992	11.2	3,105,072	6,572,232	23.73	2.12	89.1
1930	1,041	304	316,165	10.3	3,271,576	5,185,762	16.40	1.59	76.5
1931	819	304	248,572	9.5	2,352,387	4,829,076	19.43	2.05	78.0
1932	614	266	163,589	8.5	1,390,360	3,246,404	19.84	2.33	86.6
1933	716	185	132,277	8.3	1,098,053	2,671,577	20.20	2.43	89.9
10. Colorado, Montana, Utah, Wyoming, and Idaho:									
1928	426	272	115,798	8.2	952,184	2,195,000	18.96	2.31	79.2
1929	361	239	86,335	8.5	729,668	1,746,759	20.23	2.39	64.8
1930	361	216	77,868	8.7	680,140	1,538,208	19.75	2.26	67.8
1931	282	220	62,088	8.8	544,824	1,571,760	25.32	2.88	70.9
1932	252	189	47,713	8.0	381,707	1,013,850	21.25	2.66	79.8
1933	224	212	47,463	8.0	379,694	788,254	16.61	2.08	63.4
11. California:									
1928	1,622	362	586,588	8.4	4,927,884	12,003,129	20.46	2.44	88.5
1929	1,540	351	540,356	8.6	4,643,810	11,962,447	22.14	2.58	91.4
1930	1,201	333	399,356	8.4	3,372,637	8,529,165	21.36	2.53	84.2
1931	922	321	295,596	8.1	2,399,604	6,399,020	21.65	2.67	82.7
1932	736	302	222,125	7.9	1,756,418	4,569,080	20.57	2.60	83.3
1933	994	284	281,926	7.2	2,034,687	6,096,513	21.62	3.00	85.1
12. Oregon and Washington:									
1928	660	290	191,426	8.0	1,531,408	3,437,811	17.96	2.24	86.8
1929	654	275	179,879	8.0	1,439,032	2,799,246	15.56	1.95	82.5
1930	670	280	187,930	8.1	1,516,190	3,542,259	18.85	2.34	86.6
1931	462	271	125,401	8.0	1,003,208	2,707,130	21.59	2.70	90.0
1932	310	181	57,811	8.0	462,478	1,343,568	23.24	2.91	84.8
1933	426	106	44,976	7.0	312,876	755,092	16.79	2.41	83.2
STATE [2]									
Alabama:									
1928	676	318	214,978	11.0	2,372,756	6,749,202	31.39	2.84	100.0
1929	666	305	203,374	9.9	2,003,295	[3] 5,241,356	25.77	2.62	[3] 104.7
1930	602	326	196,180	10.0	1,953,160	4,821,141	24.58	2.47	100.0
1931	588	283	166,576	9.2	1,536,188	4,446,902	26.70	2.89	100.0
1932	504	119	60,174	9.6	576,232	1,453,374	24.15	2.52	100.0
1933	444	208	92,446	7.3	671,223	1,968,513	21.29	2.93	100.0
Illinois:									
1928	1,236	359	444,202	8.5	3,783,458	7,334,833	16.51	1.94	100.0
1929	1,284	333	427,266	8.9	3,783,128	8,242,725	19.29	2.18	100.0
1930	1,075	326	350,309	8.7	3,050,936	7,934,563	22.65	2.60	100.0
1931	866	274	236,936	8.6	2,034,328	6,407,191	27.04	3.15	100.0
1932	647	269	174,100	7.6	1,325,857	5,460,131	31.36	4.12	99.6
1933	955	199	190,158	6.8	1,296,489	3,973,853	20.90	3.07	100.0

[2] Michigan, Texas, and California listed as districts 4, 9, and 11, respectively; separate data not available for States other than those shown.

[3] Includes small quantity of special cements, figures for which cannot be separated from those for standard portland.

Mill employees in the cement industry, finished cement produced at mills included in study, and average output per man in the United States, 1928–33, by districts and by States—Continued

District, State, and year	Employment—cement mill only					Production			Percent of industry represented
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
STATE—contd.									
Iowa:									
1928	973	305	296, 986	11. 4	3, 388, 496	5, 514, 030	18. 57	1. 63	80. 0
1929	876	318	278, 640	11. 3	3, 135, 066	4, 975, 233	17. 86	1. 59	78. 1
1930	883	342	302, 313	10. 9	3, 304, 794	5, 333, 779	17. 64	1. 61	75. 2
1931	707	276	195, 116	10. 7	2, 084, 792	4, 260, 853	21. 84	2. 04	73. 4
1932	577	236	136, 245	11. 1	1, 516, 823	3, 078, 819	22. 60	2. 03	72. 1
1933	890	145	129, 306	7. 7	999, 797	2, 351, 922	18. 19	2. 35	77. 3
Kansas:									
1928	1, 194	321	382, 931	8. 7	3, 318, 487	6, 574, 219	17. 17	1. 98	100. 0
1929	1, 011	324	327, 466	8. 6	2, 813, 889	[3] 6, 965, 344	21. 27	2. 48	[3] 103. 3
1930	1, 020	309	315, 542	8. 4	2, 660, 556	6, 012, 360	19. 05	2. 26	100. 0
1931	684	289	197, 586	8. 4	1, 661, 414	4, 030, 874	20. 40	2. 43	99. 7
1932	406	232	94, 073	8. 2	774, 092	2, 295, 541	24. 40	2. 97	100. 0
1933	460	242	111, 450	7. 2	804, 603	2, 201, 182	19. 75	2. 74	100. 0
Missouri:									
1928	1, 141	316	360, 331	8. 5	3, 064, 355	7, 358, 504	20. 42	2. 40	93. 4
1929	1, 122	322	361, 434	8. 7	3, 130, 411	7, 373, 068	20. 40	2. 36	90. 9
1930	1, 124	317	356, 849	8. 6	3, 062, 780	6, 864, 618	19. 24	2. 24	87. 9
1931	711	314	223, 354	8. 6	1, 923, 182	5, 125, 394	22. 95	2. 67	90. 4
1932	346	325	112, 340	8. 2	921, 528	3, 335, 105	29. 69	3. 62	78. 7
1933	812	235	190, 435	6. 3	1, 195, 471	3, 500, 568	18. 38	2. 93	92. 2
New York:									
1928	1, 544	351	542, 099	9. 4	5, 111, 880	10, 156, 286	18. 74	1. 99	92. 7
1929	1, 528	343	524, 331	9. 1	4, 771, 943	10, 099, 096	19. 26	2. 12	93. 8
1930	1, 678	335	561, 509	9. 1	5, 118, 769	9, 492, 681	16. 91	1. 85	91. 5
1931	1, 439	318	458, 008	8. 8	4, 045, 856	9, 076, 813	19. 82	2. 24	95. 7
1932	1, 271	278	353, 229	8. 0	2, 841, 002	6, 006, 874	17. 01	2. 11	99. 9
1933	1, 131	236	266, 710	6. 9	1, 847, 476	4, 124, 892	15. 47	2. 23	98. 1
Ohio:									
1928	1, 164	318	369, 960	9. 1	3, 379, 235	6, 410, 097	17. 33	1. 90	69. 4
1929	954	328	312, 581	9. 2	2, 886, 704	6, 624, 718	21. 19	2. 29	70. 3
1930	780	304	237, 021	9. 5	2, 254, 412	6, 191, 515	26. 12	2. 75	71. 7
1931	700	285	199, 475	8. 2	1, 631, 796	4, 702, 285	23. 57	2. 88	77. 5
1932	691	208	143, 811	8. 3	1, 188, 506	3, 218, 511	22. 38	2. 71	80. 4
1933	672	190	127, 578	7. 9	1, 007, 781	2, 272, 778	17. 81	2. 26	81. 7
Pennsylvania:									
1928	5, 905	342	2, 021, 548	9. 7	19, 667, 720	39, 417, 398	19. 50	2. 00	94. 9
1929	5, 771	340	1, 964, 195	9. 6	18, 886, 162	37, 205, 351	18. 94	1. 97	94. 5
1930	5, 329	335	1, 784, 953	9. 1	16, 319, 906	35, 078, 404	19. 65	2. 15	92. 7
1931	4, 122	298	1, 227, 962	8. 7	10, 636, 064	26, 453, 821	21. 54	2. 49	92. 8
1932	3, 007	261	784, 083	8. 2	6, 441, 659	14, 425, 034	18. 40	2. 24	91. 3
1933	3, 396	194	657, 965	7. 2	4, 734, 424	11, 374, 925	17. 29	2. 40	92. 5
Tennessee:									
1928	632	312	196, 985	9. 6	1, 883, 955	4, 328, 044	21. 97	2. 30	92. 3
1929	526	303	159, 487	9. 6	1, 538, 968	3, 617, 591	22. 68	2. 35	81. 4
1930	390	279	108, 698	9. 5	1, 037, 095	3, 022, 194	27. 80	2. 91	78. 0
1931	372	267	99, 350	8. 8	869, 794	2, 464, 438	24. 81	2. 83	74. 6
1932	297	143	42, 599	9. 0	381, 581	1, 148, 210	26. 95	3. 01	74. 2
1933	308	187	57, 622	7. 9	452, 715	1, 030, 216	17. 88	2. 28	76. 5

[3] Includes small quantity of special cements, figures for which cannot be separated from those for standard portland.

Quarry and crusher employees in the cement industry, material (quarry rock and overburden) handled at quarries included in study, and average output of material per man in the United States, 1929–33, by districts and by States

District, State, and year	Employment—quarry and crusher only					Material handled—quarry rock and overburden				Percent of industry represented[1]
	Average number of men	Time employed				Short tons	Percent of overburden included	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours				Per shift	Per hour	
				Average per man per day	Total					
DISTRICT										
1. Eastern Pennsylvania, New Jersey, and Maryland:										
1929	860	292	251,080	9.6	2,408,708	10,414,414	5.2	41.48	4.32	95.0
1930	871	268	233,122	9.3	2,164,411	9,308,184	5.5	39.93	4.30	89.2
1931	801	251	201,166	9.0	1,801,357	8,075,951	3.8	40.15	4.48	95.4
1932	771	184	141,811	9.2	1,311,387	4,501,272	1.0	31.74	3.43	93.8
1933	791	170	134,143	7.1	951,484	3,493,537	4.3	26.04	3.67	94.5
2. New York and Maine:										
1929	325	275	89,453	9.5	852,987	2,827,162	5.9	31.60	3.31	94.2
1930	341	270	91,986	9.2	844,467	2,970,706	8.7	32.30	3.52	92.2
1931	326	255	83,210	9.2	768,588	2,773,923	7.6	33.34	3.61	96.0
1932	279	208	58,131	8.9	519,873	1,672,507	.6	28.77	3.22	99.9
1933	307	140	43,130	7.7	331,641	1,030,585	.8	23.89	3.11	98.3
3. Ohio, western Pennsylvania, and West Virginia:										
1929	797	257	204,944	10.0	2,041,697	5,757,360	25.4	28.09	2.82	57.7
1930	749	222	166,526	9.2	1,529,924	5,656,242	32.0	33.97	3.70	60.3
1931	633	174	110,418	8.5	940,656	2,888,376	6.0	26.16	3.07	63.9
1932	487	177	86,422	8.1	697,120	1,775,902	6.3	20.55	2.55	67.3
1933	560	152	85,114	7.9	670,186	2,075,917	17.7	24.39	3.10	75.0
4. Michigan:										
1929	110	266	29,213	10.5	308,090	914,440	-------	31.30	2.97	48.9
1930	98	261	25,532	10.0	255,320	768,175	-------	30.09	3.01	57.0
1931	57	195	11,131	8.2	91,177	400,280	-------	35.96	4.39	58.5
1932	50	217	10,874	8.0	86,994	265,394	-------	24.41	3.05	54.5
1933	59	190	11,195	9.3	104,111	244,472	-------	21.84	2.35	56.2
5. Wisconsin, Illinois, Indiana, and Kentucky:										
1929	478	281	134,442	8.6	1,155,752	6,455,237	46.9	48.02	5.59	54.1
1930	450	245	110,404	8.5	933,088	3,680,893	23.2	33.34	3.94	54.8
1931	418	221	92,284	8.8	815,222	4,403,229	30.6	47.71	5.40	69.8
1932	371	239	88,516	7.9	697,498	3,124,424	25.3	35.30	4.48	91.3
1933	451	152	68,708	6.9	471,142	2,077,074	10.7	30.23	4.41	80.7
6. Virginia, Tennessee, Alabama, Georgia, Florida, and Louisiana:										
1929	535	274	146,515	9.9	1,457,436	3,091,382	3.4	21.10	2.12	75.2
1930	632	239	151,276	9.7	1,462,817	3,954,575	3.3	26.14	2.70	93.4
1931	587	219	128,556	9.5	1,227,022	3,650,858	9.4	28.40	2.98	90.5
1932	576	113	65,234	9.1	595,398	1,560,395	7.8	23.92	2.62	92.9
1933	481	139	66,975	8.0	535,793	1,592,467	4.3	23.78	2.97	93.8
7. Eastern Missouri, Iowa, Minnesota, and South Dakota:										
1929	591	285	168,494	11.1	1,874,777	4,934,220	21.8	29.28	2.63	82.0
1930	646	278	179,453	9.4	1,679,324	5,725,202	30.1	31.90	3.41	76.6
1931	446	203	90,661	9.0	813,696	3,845,204	21.2	42.41	4.73	77.3
1932	276	233	64,420	8.9	571,789	2,275,879	16.0	35.33	.398	69.1
1933	523	186	97,505	6.9	670,643	2,074,023	17.6	21.27	30.9	78.5

[1] Calculated for each year by dividing the quantity of finished cement produced at mills included in study by the total production.

Quarry and crusher employees in the cement industry, material (quarry rock and overburden) handled at quarries included in study, and average output of material per man in the United States, 1929–33, by districts and by States—Continued

District, State, and year	Employment—quarry and crusher only					Material handled—quarry rock and overburden				Percent of industry represented
	Average number of men	Time employed				Short tons	Percent of overburden included	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours				Per shift	Per hour	
				Average per man per day	Total					
DISTRICT—contd.										
8. Western Missouri, Nebraska, Kansas, Oklahoma, and Arkansas:										
1929	370	305	112, 967	9. 3	1, 052, 934	3, 270, 572	5. 0	28. 95	3. 11	94. 5
1930	353	287	101, 263	9. 2	933, 577	3, 106, 852	. 7	30. 68	3. 33	80. 3
1931	245	250	61, 151	8. 2	498, 951	2, 306, 917	. 9	37. 72	4. 62	84. 0
1932	186	180	33, 402	7. 5	251, 671	1, 390, 983	1. 5	41. 64	5. 53	74. 6
1933	195	178	34, 699	7. 1	246, 144	1, 204, 966	. 1	34. 73	4. 90	84. 4
9. Texas:										
1929	221	291	64, 272	9. 3	597, 520	1, 551, 960	-------	24. 15	2. 60	89. 1
1930	134	197	26, 427	9. 9	261, 507	1, 152, 930	. 8	43. 63	4. 41	65. 0
1931	116	191	22, 152	9. 3	205, 992	1, 099, 926	1. 1	49. 65	5. 34	78. 0
1932	113	160	18, 095	8. 4	151, 375	904, 921	2. 4	50. 01	5. 98	86. 6
1933	126	120	15, 075	8. 4	127, 045	754, 143	. 6	50. 03	5. 94	89. 9
10. Colorado, Montana, Utah, Wyoming, Idaho:										
1929	104	245	25, 527	8. 4	214, 894	557, 277	-------	21. 83	2. 59	64. 8
1930	82	210	17, 184	8. 8	151, 493	544, 675	-------	31. 70	3. 60	67. 8
1931	33	208	6, 874	8. 1	55, 532	761, 185	-------	110. 73	13. 71	63. 3
1932	59	212	12, 515	8. 0	100, 230	404, 120	-------	32. 29	4. 03	79. 8
1933	32	159	5, 076	8. 0	40, 607	192, 894	-------	38. 00	4. 75	52. 2
11. California:										
1929	520	304	158, 129	8. 5	1, 336, 887	3, 486, 993	5. 2	22. 05	2. 61	91. 4
1930	415	278	115, 538	8. 3	958, 163	2, 558, 991	1. 2	22. 15	2. 67	84. 2
1931	337	255	85, 826	8. 3	711, 231	2, 072, 204	6. 8	24. 14	2. 91	82. 7
1932	234	214	50, 145	8. 3	414, 700	1, 505, 782	3. 7	30. 03	3. 63	83. 3
1933	333	240	79, 795	7. 6	608, 854	1, 867, 372	3. 8	23. 40	3. 07	85. 1
12. Oregon and Washington:										
1929	212	269	56, 928	8. 4	477, 570	852, 969	3. 8	14. 98	1. 79	82. 5
1930	168	270	45, 289	8. 0	362, 312	988, 905	4. 4	21. 84	2. 73	86. 6
1931	142	257	36, 495	8. 0	291, 960	713, 511	4. 5	19. 55	2. 44	90. 0
1932	78	174	13, 548	7. 9	107, 307	281, 004	-------	20. 74	2. 62	67. 0
1933	96	105	10, 043	7. 0	69, 990	134, 368	. 4	13. 38	1. 92	44. 7
STATE [2]										
Alabama:										
1929	196	277	54, 288	10. 0	544, 075	1, 326, 338	-------	24. 43	2. 44	94. 0
1930	205	243	49, 732	9. 7	482, 685	1, 522, 313	1. 0	30. 61	3. 15	100. 0
1931	202	182	36, 838	9. 4	346, 312	1, 190, 462	-------	32. 32	3. 44	92. 6
1932	218	63	13, 717	9. 7	132, 412	405, 353	2. 5	29. 55	3. 06	100. 0
1933	143	150	21, 435	7. 4	159, 541	542, 962	-------	25. 33	3. 40	98. 3
Illinois:										
1929	288	314	90, 550	8. 2	746, 416	5, 477, 929	53. 9	60. 50	7. 34	100. 0
1930	277	285	78, 840	8. 1	634, 832	2, 676, 877	30. 4	33. 95	4. 22	100. 0
1931	236	257	60, 701	8. 1	489, 308	3, 318, 401	37. 2	65. 64	6. 78	100. 0
1932	202	250	50, 551	7. 7	387, 163	2, 030, 009	35. 3	40. 16	5. 24	100. 0
1933	220	165	36, 407	6. 9	251, 797	1, 294, 026	9. 9	35. 54	5. 14	100. 0
Iowa:										
1929	190	283	53, 693	10. 1	543, 722	2, 011, 721	21. 2	37. 47	3. 70	78. 1
1930	261	303	78, 968	9. 9	782, 584	2, 243, 036	22. 4	28. 40	2. 87	75. 2
1931	158	217	34, 217	9. 6	329, 244	1, 872, 881	32. 0	54. 74	5. 69	73. 4
1932	131	203	26, 572	9. 3	246, 799	1, 058, 717	32. 2	39. 84	4. 29	59. 4
1933	130	165	21, 428	7. 1	152, 957	821, 058	33. 0	38. 32	5. 37	65. 6

[2] Michigan, Texas, and California listed as districts 4, 9, and 11, respectively; separate data not available for States other than those shown.

Quarry and crusher employees in the cement industry, material (quarry rock and overburden) handled at quarries included in study, and average output of material per man in the United States, 1929–33, by districts and by States—Continued

District, State, and year	Employment—quarry and crusher only					Material handled—quarry rock and overburden				Percent of industry represented
	Average number of men	Time employed				Short tons	Percent of overburden included	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours				Per shift	Per hour	
				Average per man per day	Total					
STATE—contd.										
Kansas:										
1929	177	268	47, 409	8. 7	412, 040	1, 966, 206	8. 4	41. 47	4. 77	[3] 103. 3
1930	156	261	40, 776	8. 4	343, 246	1, 511, 425	1. 4	37. 07	4. 40	82. 7
1931	111	253	28, 104	7. 8	219, 660	1, 170, 424	. 5	41. 65	5. 33	97. 2
1932	96	138	13, 230	9. 0	119, 161	619, 923	. 4	46. 86	5. 20	100. 0
1933	118	138	16, 329	7. 9	128, 221	596, 915	. 2	36. 56	4. 66	100. 0
Missouri:										
1929	389	288	111, 945	11. 7	1, 308, 207	2, 787, 210	23. 1	24. 90	2. 13	90. 9
1930	372	259	96, 427	9. 0	864, 276	3, 326, 825	36. 8	34. 50	3. 85	87. 9
1931	275	195	53, 584	8. 6	460, 252	1, 832, 091	11. 7	34. 19	3. 98	90. 4
1932	131	274	35, 896	8. 6	309, 232	1, 130, 093	2. 1	31. 48	3. 65	78. 7
1933	379	196	74, 327	6. 7	497, 654	1, 172, 810	8. 0	15. 78	2. 36	92. 2
New York:										
1929	301	273	82, 157	9. 6	787, 323	2, 616, 839	4. 8	31. 85	3. 32	93. 8
1930	308	261	80, 370	9. 1	728, 307	2, 572, 946	4. 7	32. 01	3. 53	91. 5
1931	294	243	71, 530	9. 1	651, 788	2, 468, 399	4. 9	34. 51	3. 79	95. 7
1932	262	207	54, 276	8. 9	485, 197	1, 513, 977	. 7	27. 89	3. 12	99. 9
1933	290	143	41, 566	7. 7	320, 922	971, 177	8. 1	23. 36	3. 03	98. 1
Ohio:										
1929	260	251	65, 281	9. 3	603, 856	1, 929, 913	8. 2	29. 56	3. 20	70. 3
1930	259	227	58, 911	9. 4	553, 523	1, 676, 227	4. 3	28. 45	3. 03	71. 7
1931	245	169	41, 513	8. 8	365, 274	1, 433, 576	7. 8	34. 53	3. 92	77. 5
1932	238	157	37, 379	8. 6	323, 199	990, 128	11. 3	26. 49	3. 06	80. 3
1933	248	125	31, 088	7. 7	239, 626	791, 024	15. 5	25. 44	3. 30	81. 7
Pennsylvania:										
1929	925	276	255, 672	9. 8	2, 513, 761	11, 334, 539	16. 0	44. 33	4. 51	84. 0
1930	951	249	236, 410	9. 3	2, 186, 945	10, 800, 843	20. 4	45. 69	4. 94	78. 9
1931	844	219	184, 535	8. 8	1, 625, 259	7, 538, 568	4. 6	40. 85	4. 64	86. 7
1932	695	193	134, 231	9. 0	1, 206, 448	4, 075, 492	. 8	30. 36	3. 38	85. 8
1933	785	163	128, 047	7. 3	930, 119	3, 664, 179	10. 5	28. 62	3. 94	89. 2
Tennessee:										
1929	77	257	19, 794	9. 9	195, 641	532, 944	1. 6	26. 92	2. 72	46. 1
1930	164	231	37, 904	9. 3	353, 420	948, 934	2. 1	25. 04	2. 69	78. 0
1931	141	188	26, 550	9. 4	248, 342	608, 832	. 7	22. 93	2. 45	74. 6
1932	131	75	9, 783	9. 1	89, 190	254, 807	. 4	26. 05	2. 86	74. 2
1933	96	105	10, 083	8. 7	87, 789	256, 180	. 3	25. 41	2. 92	76. 5

[3] Based on production including small quantity of special cements, figures for which cannot be separated from those for standard portland.

SPECIAL CEMENTS

At the June meeting of the American Society for Testing Materials, upon recommendation of committee C–1, the tentative specification for high-early-strength cement, C74–30T, was continued for another year.

The committee also considered proposed specifications for two other special types of cement—one featuring low heat of hydration and the other both moderately low heat of hydration and resistance to active sulphate solutions such as sea water or alkali-salt solutions. No definite action was taken toward adoption of tentative specifications for these two types of cement, but the proposed specifications were referred to working committees for further studies.

Of particular significance is the fact that virtually all engineering projects using large quantities of cement commonly require cement meeting specifications other than those for standard portland cement. For example, Boulder Dam was responsible for the development of "low-heat cement", the Tennessee Valley Authority has contracted for the purchase of a large quantity of "Type B" sulphate-resistant cement with a moderately low heat of hydration for use in the construction of Wheeler and Norris Dams, and a similar sulphate-resistant cement is to be used for the Fort Peck Dam.

Statistics of special cements.—The following table summarizes preliminary statistics of special cements in the United States in 1934 compared with final figures for 1933.

Statistics of special cements in the United States, 1933–34

Type	1933	1934 [1]	Percent of change in 1934
High-early-strength and "Super" cements:			
Production ... barrels	1,207,559	2,235,570	+85.1
Shipments ... do	1,276,120	2,060,572	+61.5
Value of shipments	$2,509,773	$3,972,014	+58.3
Unit factory value	$1.97	$1.93	−2.0
Masonry cement (portland): [2]			
Production ... barrels	398,289	441,330	+10.8
Shipments ... do	405,814	405,138	−.2
Value of shipments	$545,393	$550,588	+1.0
Unit factory value	$1.34	$1.36	+1.5
Miscellaneous special cements: [3]			
Production ... barrels	680,187	2,269,130	+233.6
Shipments ... do	584,852	2,033,689	+247.7
Value of shipments	$1,010,372	$3,270,889	+223.7
Unit factory value	$1.73	$1.61	−6.9

[1] Subject to revision.
[2] Includes only masonry cements of the portland-cement class.
[3] Includes so-called "temperature-resisting", "sea-water", "high-silica", "tufa", and "oil-well" cements.

Shipments of natural, masonry (natural), and puzzolan cements in 1933 totaled 432,415 barrels valued at $571,648, an average of $1.32 a barrel. Comparable figures for 1934 are not yet available, but judging from the continued slump in building construction, particularly residential, little change from 1933 can be expected.

Statistics of white portland cement and alumina cement are not available for publication.

FOREIGN TRADE [6]

Cement imported for consumption in 1934 amounted to only 265,999 barrels valued at $264,416, a decrease of 44 percent in quantity and 34 percent in value from 477,193 barrels valued at $400,153 in 1933. The quantity in 1934 is the smallest imported since 1921 when 122,317 barrels were reported. The tariff of $0.06 per hundredweight was in effect during 1933 and 1934.

Imports equaled 0.74 percent of shipments from domestic mills in 1933 and 0.35 percent in 1934. Although imports comprise a

[6] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

relatively insignificant part of total cement consumption, competition from imported cement may be felt keenly in ports of entry and adjacent territory.

Exports of portland cement dropped 17 percent—from 680,307 barrels in 1933 to 566,462 barrels in 1934—but the unit value of exports advanced from $2.19 in 1933 to $2.36 in 1934. Export statistics do not include shipments to Alaska, Hawaii, and Puerto Rico, which increased from 265,598 barrels in 1933 to 487,174 barrels in 1934.

TECHNOLOGIC PROGRESS

Construction of a new plant and application of the flotation process to cement raw materials were the outstanding contributions to technologic progress during 1934.

Plant construction.—The new plant of the National Portland Cement Co. at Brodhead, near Bethlehem, Pa., was virtually completed at the end of the year, and production began early in 1935. Trauffer [7] visited Brodhead during the summer of 1934 and reported that the design of the plant incorporates the latest approved equipment and methods of operation.

The plant is designed for wet-process manufacture. Two rotary kilns (10 feet in diameter by 372 feet long and equipped with coolers) are provided, and additional kilns can be added without changing the general plant lay-out. A covered storage building provides space for 100,000 barrels of clinker, 4 weeks' supply of stone, and 6 months' supply of coal. Storage facilities for finished cement consist of 25 silos with a total capacity of 250,000 barrels.

Flotation.—The installation by the Valley Forge Cement Co. of flotation equipment capable of treating more than 1,000 tons of kiln feed a day was by far the outstanding technologic development in the cement industry in 1934.[8] Successful flotation of calcite and other nonmetals is not a new development, but the treatment of virtually the entire output of the raw mills in a complete concentrating plant opens vast possibilities for absolute control of the chemical and mineralogical content of cement raw materials.

Advantages claimed by the sponsors of flotation treatment include: An appreciable increase in reserves through utilization of lower-grade stone; reduced quarry costs through elimination of selective quarrying; decreased grinding costs for both raw rock and clinker; lower fuel costs; elimination of purchases of high-grade limestone; production of more uniform cement possessing higher early and ultimate strength; economical production of special cements through control of kiln feed; and possible commercial utilization of quartz and other materials in the tailings. The principal disadvantages are the necessary increases in capital expenditures and operating costs. Officials in charge of the Valley Forge installation report that actual operation has demonstrated that savings effected more than offset increased costs.

[7] Trauffer, W. E., Cement Industry's Only New Plant Nears Completion in Lehigh Valley: Pit and Quarry, vol. 27, no. 1, July 1934, pp. 39–40.

[8] Rockwood, N. C., Chemistry Applied toCement Manufacture: Rock Products, vol. 37, no. 8, August 1934, pp. 32–37.

Pit and Quarry, Standard and Special Cement Can Be Made of Inferior Raw Materials: Vol. 27, no. 1, July 1934, pp. 41–42.

Miller, B. L., and Breerwood, C. H., Flotation Processing of Limestone: Am. Inst. Min. and Met. Eng. Tech. Pub. 606, February 1935, 22 pp.

Olive, T. R., Flotation Solves a Problem in Process Raw Materials: Chem. and Met. Eng., vol. 42, no. 2, February 1935, pp. 68–72.

Clinker cooling.—Problems of clinker cooling were considered by the cement industry in 1934. Larmour[9] concluded as the result of his investigations that proper cooling will increase grindability of the clinker. Tests showed that the grinding rate could be increased from 52 barrels per hour for untreated clinker to 65 barrels for treated clinker with an increase also in the comparative strength of the finished products. He recommended that any reducing condition in the kiln be practiced only at a temperature close to that required for clinkering; lower temperatures may toughen the clinker. He concluded further that reduction may be the basis for producing cements of varying colors.

Shaker-grate and traveling-grate coolers were installed in at least two mills during 1934.[10]

Combustion economy.—In an introduction to a series of articles on combustion economy in rotary kilns, Schultz[11] outlined the following economies which might be expected: An increase in tensile strength of 25 to 75 pounds per square inch; a saving in fuel consumption of 150,000 to 500,000 B. t. u. per barrel of clinker; an increase in clinker capacity of 10 to 25 percent; and an increase in life of the kiln lining of 100 to 300 percent.

Trauffer[12] described the installation of recuperators at one plant. A Pennsylvania mill installed a preheating system which is reported to effect a fuel saving of 40 percent.[13]

The use in Europe of a new device called the "evaporator" to attain complete drying of the slurry was described by Goebels.[14] The development also was reported[15] of a new suspended-chain process for drying slurry in the kiln itself.

Heat of hydration.—Lerch and Bogue[16] reported the results of their extensive researches on the heat of hydration of portland cement, a timely topic in view of the interest in low heat and moderately low-heat cements. The type of calorimeter developed during their investigation is now in use in numerous cement laboratories.

Dust collecting.—Two plants[17] reported the installation of dust-collector units in 1934. Electrofilters have been used as dust collectors in various European industries, including cement plants.[18]

Grinding equipment.—A new compound tube mill with the fine-grinding compartment subdivided into five longitudinal cells was reported to have been tested in Europe.[19] Savings of 23 to 29 percent in power consumption were claimed.

New pulverizers and separators were installed at several mills during 1934.[20]

[9] Larmour, H. McC., Clinker Cooling Studies: Rock Products, vol. 37, no. 7, July 1934, pp. 40–44.
[10] Rock Products, $650,000 Modernization Program Completed: Vol. 38, no. 1, January 1935, pp. 40–41.
[11] Schultz, R. S., Jr., Combustion Economy in the Rotary Cement Kiln: Rock Products, vol. 37, no. 7, July 1934, pp. 38–39; no. 9, September 1934, pp. 36–37; no. 11, November 1934, pp. 24–25; vol. 38, no. 1, January 1935, pp. 18–21; no. 3, March 1935, pp. 32–33.
[12] Trauffer, W. E., Recuperators on Cement Kilns Reduce Fuel Rate and Increase Capacity: Pit and Quarry, vol. 27, no. 1, July 1934, pp. 29–32.
[13] Pit and Quarry, Survey Reveals 1930–1934 Period Was One of Advance in Cement Field: Vol. 27, no. 7, January 1935, pp. 41–50.
[14] Goebels, Paul, Attain Complete Drying of Slurry with New Installation: Concrete, vol. 42, no. 5, May 1934, pp. 35–37.
[15] Concrete, Develop New Suspended-Chain Process for Drying Slurry in Kiln: Vol. 42, no. 10, October 1934, pp. 35–36.
[16] Lerch, Wm., and Bogue, R. H., The Heat of Hydration of Portland Cement Pastes: Concrete, vol. 42, no. 4, April 1934, pp. 36–42; vol. 42, no. 5, May 1934, pp. 39–42.
[17] See footnote 12.
[18] Concrete, Electrofilter Makes Rapid Advance in European Industry: Vol. 43, no. 2, February 1935, pp. 37–41.
[19] Concrete, Power Requirements Greatly Reduced in New Compound Tube Mill: Vol. 42, no. 11, November 1934, pp. 35–37.
[20] See footnote 12.

Transportation and storage.—Several companies [21] reported improvements in transportation and storage facilities for both raw rock and finished cement. One company on the Pacific coast has virtually completed an extensive construction program for distribution of cement by water. This includes a steel-and-concrete dock extending 2,370 feet into the ocean, a Fuller-Kinyon pumping system, a self-unloading boat, additional storage facilities at numerous destinations, and new automatic scales for weighing carload shipments. Storage silos also were built at several other mills in 1934. A Pennsylvania company put in operation a 5,150-foot cable tramway with an hourly capacity of 250 tons to transport limestone from the quarry to the mill. Another company replaced its quarry cars and locomotives with large-capacity dump trucks.

To provide additional rolling stock to haul cement in bulk, one railroad company rebuilt box cars by installing four hoppers with gravity-unloading gates and building wooden slopes inside each car.[22]

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[21] See footnote 12.

[22] Concrete, Box Cars Become Gravity-Unloading Bulk-Cement Carriers: Vol. 43, no. 2, February 1935, pp. 35–36.

DIMENSION STONE[1]

By Oliver Bowles and A. T. Coons

SUMMARY OUTLINE

Activity in the dimension-stone industries continued to decline in 1934. Preliminary figures furnished by producers indicate that sales of all kinds of stone marketed as blocks or slabs decreased 22 percent in quantity and 3 percent in value compared with 1933. Sales totaled about 1,342,500 short tons valued at about $18,382,000. Sales of the higher-grade building stones declined sharply, and of monumental stone increased moderately, while the lower-priced grades sold for rough construction made marked increases.

The principal kinds of dimension stone are granite, marble, limestone, sandstone, basalt, and slate. Although the slate industry is reviewed in a separate chapter, to show total sales of dimension stone each year the figures for slate are included also in the table of salient statistics of this chapter.

Dimension-stone producers may be divided into three main groups on the basis of plant operation; the first group includes operators who quarry stone and sell it as rough blocks or slabs; the second group quarries and manufactures stone into finished products; and the third buys sawed or rough stock and manufactures products but does not operate quarries.

The Bureau of Mines statistical canvass covers the first and second groups, but as the third group includes manufacturers rather than producers it is canvassed by the Bureau of the Census. Bureau of Mines statistics are compiled from reports of tonnages and values of original sales. It is evident therefore that the figures include some material sold as rough blocks and some sold as finished products.

Final figures for 1934 are not yet available; however, the following table of salient statistics shows final figures for sales of stone in 1933, preliminary figures for sales in 1934, and the percentage of change from 1933 for each kind of stone by principal products.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

Salient statistics of the dimension-stone industries in the United States, 1933–34

	1933	1934 [1]	Change from 1933
Granite:			*Percent*
Building stone:			
Rough construction ... short tons	109,820	117,000	+6.5
Value	$149,941	$219,000	+46.1
Average value per ton	$1.37	$1.87	+36.5
Cut stone, slabs, and mill blocks ... cubic feet	1,160,400	1,130,000	−2.6
Value	$2,736,223	$2,364,000	−13.6
Average value per cubic foot	$2.36	$2.09	−11.4
Monumental stone ... cubic feet	1,580,520	1,857,000	+17.5
Value	$3,962,110	$4,852,000	+22.5
Average value per cubic foot	$2.51	$2.61	+4.0
Rubble ... short tons	39,050	43,000	+10.1
Value	$36,052	$55,000	+52.6
Paving blocks ... number	5,800,680	6,775,000	+16.8
Value	$577,524	$610,000	+5.6
Curbing ... cubic feet	528,820	616,000	+16.5
Value	$489,006	$600,000	+22.7
Total value	$7,950,856	$8,700,000	+9.4
Total quantity (approximate short tons)	476,750	521,400	+9.4
Marble:			
Building stone (cut stone, slabs, and mill blocks) ... cubic feet	1,344,310	500,000	−62.8
Value	$4,877,738	$1,720,000	−64.7
Average value per cubic foot	$3.63	$3.44	−5.2
Monumental stone ... cubic feet	426,300	460,000	+7.9
Value	$1,358,770	$1,453,000	+6.9
Average value per cubic foot	$3.19	$3.16	−0.1
Total value	$6,236,508	$3,173,000	−49.1
Total quantity (approximate short tons)	150,070	81,000	−46.0
Limestone:			
Building stone:			
Rough construction ... short tons	78,790	136,000	+72.6
Value	$108,100	$147,000	+36.0
Average value per ton	$1.37	$1.08	−21.2
Cut stone, slabs, and mill blocks ... cubic feet	5,637,450	3,182,000	−43.6
Value	$6,308,123	$3,303,000	−47.6
Average value per cubic foot	$1.12	$1.04	−7.1
Rubble ... short tons	79,060	175,000	+121.4
Value	$94,046	$161,000	+71.2
Flagging ... cubic feet	78,610	104,500	+32.9
Value	$32,134	$44,000	+36.9
Total value	$6,542,403	$3,655,000	−44.1
Total quantity (approximate short tons)	550,850	539,300	−2.1
Sandstone:			
Building stone:			
Rough construction ... short tons	12,700	26,000	+104.7
Value	$42,705	$53,000	+24.1
Average value per ton	$3.36	$2.04	−39.3
Cut stone, slabs, and mill blocks ... cubic feet	668,310	337,000	−49.6
Value	$780,815	$471,000	−39.7
Average value per cubic foot	$1.17	$1.40	+19.7
Rubble ... short tons	5,830	12,000	+105.8
Value	$10,917	$20,000	+83.2
Paving blocks ... number	120,900	55,000	−54.5
Value	$8,184	$4,200	−48.7
Curbing ... cubic feet	159,980	354,000	+121.3
Value	$129,700	$275,000	+112.0
Flagging ... cubic feet	102,460	149,000	+45.4
Value	$101,693	$120,000	+18.0
Total value	$1,074,014	$943,200	−12.2
Total quantity (approximate short tons)	90,210	102,470	+13.6
Basalt:			
Building stone ... short tons	6,090	4,000	−34.3
Value	$6,777	$6,900	+1.8
Average value per ton	$1.11	$1.73	+55.9
Rubble ... short tons	3,800	6,800	+78.9
Value	$4,823	$5,100	+5.7
Total value	$11,600	$12,000	+3.4
Total quantity (approximate short tons)	9,890	10,800	+9.2

[1] Subject to revision.

Salient statistics of the dimension-stone industries in the United States, 1933–34—Continued

	1933	1934	Change from 1933
Miscellaneous:			*Percent*
Building stone [2] ... short tons	16,090	8,000	−50.3
Value	$327,517	$224,000	−31.6
Average value per ton	$20.36	$28.00	+37.5
Rubble ... short tons	13,850	13,000	−6.1
Value	$41,062	$33,000	−19.6
Total value	$368,579	$257,000	−30.3
Total quantity (approximate short tons)	29,940	21,000	−29.9
Slate [3] (approximate short tons)	73,240	66,570	−9.1
Value	$1,515,863	$1,641,828	+8.3
Total stone, by uses:			
Building stone:			
Rough construction ... short tons	223,490	291,000	+30.2
Value	$635,040	$649,900	+2.3
Cut stone, slabs, and mill blocks ... cubic feet	8,810,470	5,149,000	−41.6
Value	$14,702,899	$7,858,000	−46.6
Monumental stone ... cubic feet	2,006,820	2,317,000	+15.5
Value	$5,320,880	$6,305,000	+18.5
Paving blocks ... number	5,921,580	6,830,000	+15.3
Value	$585,708	$614,200	+4.9
Curbing ... cubic feet	688,800	970,000	+40.8
Value	$618,706	$875,000	+41.4
Flagging ... cubic feet	181,070	253,500	+40.0
Value	$133,827	$164,000	+22.5
Rubble ... short tons	141,590	249,800	+76.4
Value	$186,900	$274,100	+46.7
Slate ... short tons	73,240	66,570	−9.1
Value	$1,515,863	$1,641,828	+8.3
Grand total, value	$23,699,823	$18,382,000	−22.4
Grand total, quantity (approximate short tons)	1,380,950	1,342,540	−2.8

[2] Includes soapstone, mica schist, volcanic rocks, argillite, and other varieties that cannot be classified in the principal groups.
[3] Details are given in chapter on Slate.

Granite.—The granite industry showed definite signs of recovery in 1934, with a gain of 9 percent in both quantity and value of output compared with 1933. The largest gain was in sales of monumental stone, which increased 17 percent in quantity and 22 percent in value. Substantial gains also were recorded for rough construction stone, rubble, paving blocks, and curbing, but cut stone, slabs, and mill blocks declined 3 percent in quantity and 14 percent in value. An upturn in construction in the large industrial centers of the East would stimulate sales of granite, as the principal sources of building granite are in New England and other eastern States.

Marble.—Monumental stone, with gains of 8 percent in quantity and 7 percent in value, was the only branch of the marble industry that showed an upturn in 1934. Marble for building experienced the most drastic decline in its history, with a drop of 63 percent in quantity and 65 percent in value from 1933. Sales estimated at 500,000 cubic feet, were only about one sixth of those in 1928. Contracts for large Federal and State buildings, which have supported the industry during recent years, were less numerous and few privately owned buildings of the class that ordinarily call for marble were erected in 1934.

Limestone.—Nearly all limestone sold as blocks or slabs is used as building stone, and so few buildings employing limestone were erected in 1934 that sales of cut stone, slabs, and mill blocks declined 44 percent in quantity and 48 percent in value compared with 1933. The smaller branches of the limestone industry—rough construction stone, rubble, and flagging—made substantial gains. Indiana produced more than three fourths of all dimension limestone sold in the United States. The following tables give statistics of production in this State, by classes.

Limestone sold by producers in the Indiana oolitic limestone district, 1933 and 1934, by classes

Class	1933		1934	
	Quantity	Value	Quantity	Value
Construction:				
Rough blocks........cubic feet..	2,036,460	$733,804	1,226,420	$447,299
Sawed and semifinished........do....	369,230	239,229	445,440	342,997
Cut........do....	2,452,970	3,844,789	1,123,650	1,896,886
Total construction........do....	4,858,660	4,817,822	2,795,510	2,687,182
Other stone........short tons..	150,140	80,961	184,000	92,000
Grand total (quantities approximate, in short tons)....	502,400	4,898,783	387,000	2,779,182

Sales of Indiana limestone fabricated from rough stone purchased from quarry companies, 1933 and 1934, by classes

Sales by mills	1933 [1]		1934					
			Sawed and semifinished		Cut		Total	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
Not operated by quarry companies..........	481,970	$776,078	36,670	$60,623	256,070	$530,177	292,740	$590,800
Of quarry companies from stock obtained at quarries other than their own.	716,460	1,124,336	22,270	14,761	333,740	526,116	356,010	540,877
	1,198,430	1,900,414	58,940	75,384	589,810	1,056,293	648,750	1,131,677

[1] All cut stone; no sawed stone reported for 1933.

Sandstone.—The higher grade building sandstones sold in 1934 declined 50 percent in quantity and 40 percent in value compared with 1933. Sales of rubble and rough construction stone more than doubled those of the previous year, but these branches of the industry are relatively small. Sales of curbing and flagging also increased greatly, but the output of paving blocks fell to less than half that in 1933. Prosperity in the sandstone industry, as in other branches of the stone industries, awaits a long-delayed expansion in building.

Effects of building conditions on stone.—The dimension-stone industries depend for their markets primarily upon the building industries, principally nonresidential building, which has shown little activity for the past 5 years. According to data compiled by the F. W. Dodge Corporation contracts awarded for nonresidential building in 1934 increased 34 percent in value compared with 1933. Even with this increase in expenditures, however, nonresidential building was only 23 percent of the 1926 total.

Furthermore, the tendency to substitute lower-priced building materials for stone has had dire effects on sales. It is significant of the trend toward economy resulting from the depression that, according to the Bureau of Labor Statistics, the public buildings for which permits were issued in 1934 cost on an average only about half as much as those for which permits were issued in 1933. The buildings were smaller or low-priced materials were specified, and in either instance stone was at a disadvantage.

Figure 83 compares trends in sales of building limestone and sandstone with total and nonresidential building from 1925 to 1934. Sales of limestone maintained a high level until 1929 and declined rapidly thereafter. The sandstone industry lagged in 1928 and 1929, recovered remarkably in 1930, and thereafter suffered more or less drastic declines for 4 successive years. Both limestone and sandstone failed to follow the upward trend in building contracts in 1934.

Figure 84 shows a similar comparison for marble and granite. The marble industry attained a relatively high level of activity in 1928 and 1929 but slumped continuously thereafter, until in 1934 it reached about the lowest point in its history. The building-granite

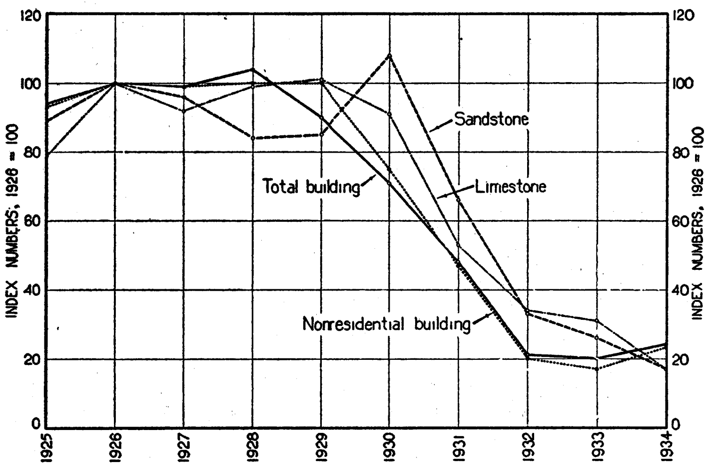

FIGURE 83.—Sales of limestone and sandstone compared with total building and nonresidential building, 1925–34. To facilitate comparison unlike units have been reduced to percentages of the 1926 value. Stone figures are from the U. S. Bureau of Mines and include rough and dressed stone; contracts are from F. W. Dodge Corporation.

industry, after precipitous declines in 1932 and 1933, responded decidedly to the upward trend in building in 1934.

Trends in sales of memorial stone.—Memorial (monumental) stone showed a more definite trend toward recovery than any other major branch of the stone industries. The quantity of granite sold for monuments in 1934 increased 17 percent and marble 8 percent compared with 1933; the unit value of granite was slightly higher and of marble slightly lower than in 1933. Unlike other branches of the stone industries sales of memorial stone depend directly upon no other industry but are governed principally by the buying power of the public. The upturn in sales, therefore, may be regarded as an indication of returning prosperity—a sign that bears promise of expansion in other branches of the stone industries.

Figure 85 shows trends in sales and unit value of memorial granite and marble from 1925 to 1934. Granite has always provided the greater quantity of material for memorial purposes and is recovering from the depression more rapidly than marble.

Code developments.—All the major branches of the dimension-stone industries operated in 1934 under codes of fair competition in coopera-

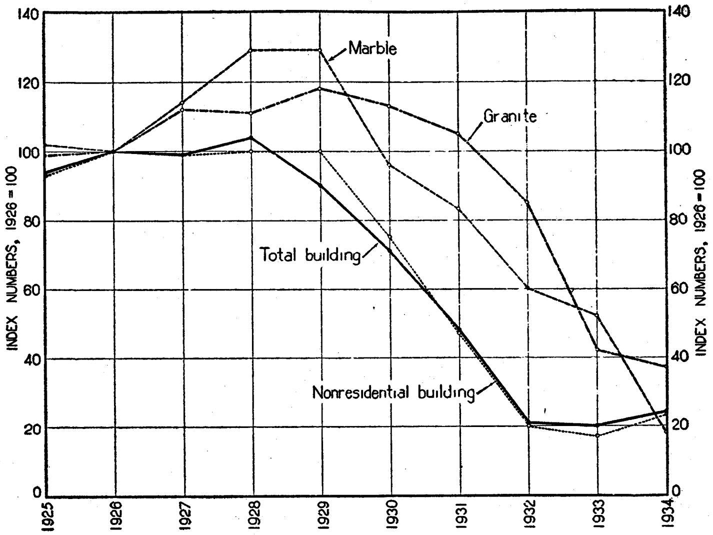

FIGURE 84.—Sales of building marble and granite compared with total building and nonresidential building, 1925–34. To facilitate comparison unlike units have been reduced to percentages of the 1926 value. Stone figures are from the U. S. Bureau of Mines and include both rough and dressed stone; contracts are from F. W. Dodge Corporation.

tion with the National Industrial Recovery Administration. Code 421 for the marble quarrying and finishing industry was approved May 9, 1934, and amended October 29, 1934. As a whole it is one

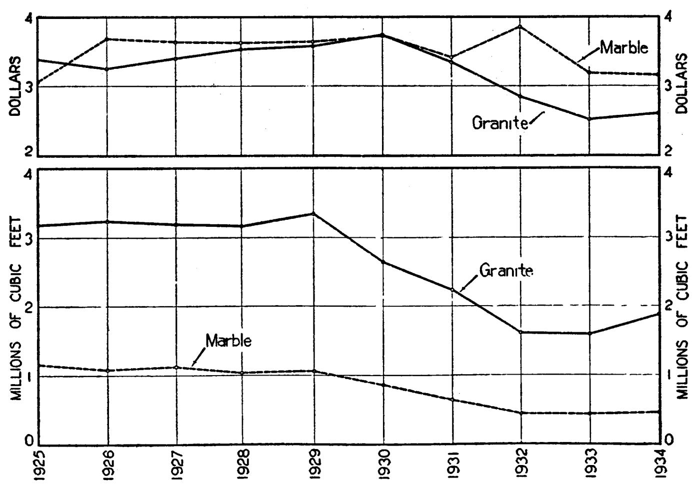

FIGURE 85.—Trends in quantity and unit value of memorial stone, 1925–34, by kinds.

of the most comprehensive codes that has been formulated. The amendment pertains to administration in the metropolitan district of the city of New York. Code 484 for the wholesale monumental-marble industry, approved July 14, 1934, conforms in most respects with the code for the quarrying and finishing industry.

Code 113 for the limestone industry was approved November 14, 1933, and amended in minor respects May 14 and July 27, 1934. The restriction against selling below cost necessitated the establishment of basic milling costs. The following costs per cubic foot for certain processes were approved by the N. R. A. for a trial period: Gang sawing, 21 cents; rip sawing, 8 cents; car blocking, 9 cents; jointing, 8 cents; storage, 1 cent. The cost of certain other processes was determined on a time basis: For example, drafting at $1.45 an hour; planing, $1.75; and cutting, $1.70. Ten percent was added to the total processing cost to cover selling and administrative expenses. Any member of the industry could petition for the privilege of establishing lower figures, but he had to prove that his costs actually were lower. If in the opinion of the Administrator the purposes of the act were not defeated thereby, the lower cost figures might be approved. All members of the industry then were permitted to use the revised figures in computing sales prices.

Code 449 for the wholesale monumental-granite industry was approved May 31, 1934. It established 11 regional committees, the chairmen of which formed the Code Authority. Building granite was covered by supplement 18, approved August 20, 1934, of Code 244 for the construction industry. The supplement described in detail methods of filing bids on contracts amounting to $5,000 or more. The Code Authority consisted of 7 members, 5 of whom were members or representatives of the National Building Granite Quarries Association, Inc., and 2 representatives of operators who were not members.

Code 388 for the sandstone industry was approved on April 6, 1934, and amended September 21, 1934. The amendment established methods of collecting and budgeting funds to cover the expenses of administering the code. A separate code, 519, approved September 11, 1934, governed the natural cleft-stone industry, which included bluestone and other thin-bedded flagstones.

Quarries that produced riprap and breakwater and jetty stone as their main products fell under the code governing the crushed-stone industry, but considerable quantities of these materials were produced as byproducts of dimension-stone quarries.

Employment conditions.—Stone, like other construction materials, is classed with durable goods. Industries producing durable goods are more subject to booms and depressions than those manufacturing nondurable goods, such as food and clothing. Figure 86 compares employment in the dimension-stone, durable-goods, and non-durable-goods industries from 1925 to 1934. Employment in both the durable and nondurable groups reached its lowest level in 1932 and thereafter recovered substantially. In the dimension-stone industries, however, employment continued to decline, dropping in 1934 to less than 31 percent of the 1923–25 average. The wide spread of the curves in 1934 indicates the lag in recovery of durable goods as a whole and the failure of dimension stone to show any promise of recovery other than a retardation in the downward trend. Indexes of pay rolls show trends similar to those of employment.

Unemployment in the dimension-stone industries has been more critical than in most industries. Data published monthly by the United States Bureau of Labor Statistics in Trend of Employment show that in December 1934, both in employment and pay rolls, the group designated "Marble, granite, slate, and other stone products" stood at the bottom of the 107 groups into which all industry is divided.

Indicators of current activity.—Even preliminary statistics of dimension-stone output for any year are available only after 5 or more months of the following year. However, data on quantity and value of current sales may be determined roughly from the indexes of employment and pay rolls compiled by the United States Bureau of Labor Statistics. The group designated "Marble, granite, slate, and other stone products" includes all building and monumental stone and, except for slate, corresponds virtually with the commodities covered in this chapter. In an average month the canvass includes about 225 establishments employing 4,500 workers—about a 50-percent coverage.

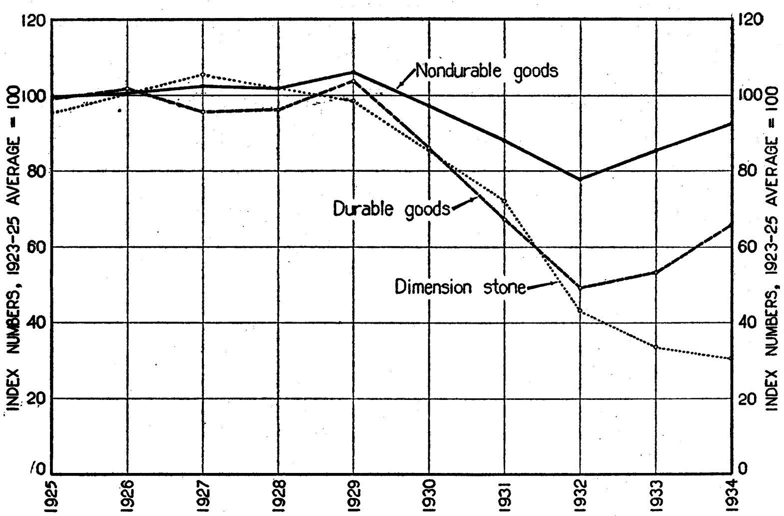

FIGURE 86.—Employment in the dimension-stone, durable-goods, and nondurable-goods industries, 1925-34. Units have been reduced to percentages of the 1923-25 average. Figures are from the U. S. Bureau of Labor Statistics.

To test the accuracy of indexes of employment as indicators of volume of production the cubic feet of dimension stone sold from 1925 to 1934 were reduced to index numbers, calculated on the same basis as the indexes of employment (percentages of the 1923-25 average), and plotted for comparison in figure 87. The general trend was found to be similar. The position of the employment curve below that of production is due partly to increased output per man, occasioned by improvements in machinery and operating efficiency. In 1933 and 1934 employment showed more evidence of recovery than production. This may be explained by the fact that the Bureau of Labor Statistics measures employment by the number of persons employed irrespective of the number of hours worked, and in these years, when efforts were being made to spread work, the actual man-hours of labor were low compared with the number of men employed. With due allowance for variations, employment indexes therefore may be used as indicators of probable production.

Figure 87 also shows a similar relationship between pay rolls and value of sales. The position of the curve for value of sales above that of pay rolls is attributed at least partly to increased plant efficiency. The pay-roll indexes were unusually low in 1933 and 1934 because, unlike the employment indexes, they are measures of work actually performed. Although the value of sales in these years appears to be high compared with pay rolls it must be remembered that much of the income was absorbed in fixed charges, such as rent, interest, taxes, pumping, and plant maintenance, that remain at about the same level all the time.

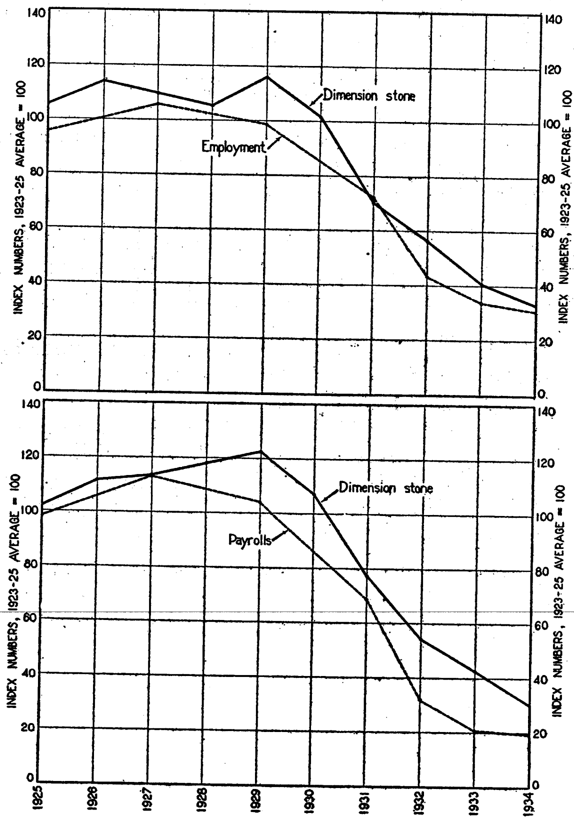

FIGURE 87.—Volume of dimension stone sold compared with conditions of employment and value compared with pay rolls, 1925–34. To facilitate comparison unlike units have been reduced to percentages of the 1923–25 average. Stone figures are from the U. S. Bureau of Mines; employment and pay rolls from the U. S. Bureau of Labor Statistics.

Technical progress.—Stone is an unusually hard, resistant material which cannot be fabricated with mechanical equipment alone. Shaping and finishing are expensive processes that involve both machine work and skilled hand labor, the proportion of waste in quarries and mills is high, and freight charges add greatly to the delivered price. For these reasons stone cannot compete on a price basis with many other building materials but must find markets chiefly on the basis of quality and service. Sales resistance can be overcome best where prices are kept at the lowest point consistent with a reasonable profit, and progressive stone producers are alert to every new process or type of equipment that will reduce production costs.

Experiments in Vermont marble quarries demonstrate that wire saws are more economical than channeling machines for making deep cuts. Successful experiments with wire saws in sandstone quarries near Amherst, Ohio, were reported early in 1935.

Some interest has been shown in a new "Bakelite" bonded abrasive wheel which reduces the cost of working granite.

A new type of stone construction, consisting of facing blocks of limestone anchored to a backing of concrete, has been developed recently.

Research organizations in many countries have contributed new facts concerning the durability of stone, reasons for decay, and methods of preservation and restoration.

FOREIGN TRADE [2]

Stone imported for consumption in the United States in 1934 was valued at $413,301, a decrease of 23 percent from 1933. The value of imports has dropped to less than one-seventh of the value recorded for 1930.

Italy supplied about 38 percent in value of the imports of marble, breccia, and onyx; Argentina was second, with nearly 32 percent; of the remaining countries, Belgium and France were the most important.

About 50 percent of granite imports, by value, originated in Finland, and about 25 percent in Sweden. All imported travertine is quarried in the Tivoli district of Italy near Rome.

Exports of stone consist chiefly of marble in rough and dressed blocks. In 1934 exports amounted to 11,475 cubic feet, valued at $44,979, compared with 11,585 cubic feet, valued at $46,031, in 1933. Canada, the United Kingdom, and Newfoundland were the principal markets for exported marble.

[2] Figures of imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

SLATE

By Oliver Bowles and A. T. Coons

SUMMARY OUTLINE

After a continuous drop for 5 consecutive years the value of slate, other than granules and flour, sold by producers in 1934, showed a moderate upturn; sales were valued at $1,641,828 compared with $1,515,863 in 1933. The quantity sold, however, declined from 73,240 short tons in 1933 to 66,570 tons in 1934. The increase of 8.3 percent in value for an output that decreased 9.1 percent in quantity reflects a substantial recovery in price levels. The gain in unit values offers some encouragement to producers, but the total value of output is still far below the level of predepression years.

Roofing slate sold in 1934 amounted to 137,010 squares valued at $1,033,164—a decrease of 10.6 percent in quantity but a gain of 6.8 percent in value compared with 1933. The average price per square at the quarry was $7.54 in 1934, whereas it was only $6.32 in 1933. The output of the New York-Vermont district was 34,980 squares valued at $302,001 compared with 42,060 squares valued at $311,000 in 1933. In the Pennsylvania district 84,690 squares valued at $585,973 were sold compared with 95,050 squares valued at $537,178 in 1933. Maine and Virginia showed small increases.

Sales of millstock in 1934 totaled 2,113,620 square feet valued at $581,959—an increase of 1 percent in quantity and 12 percent in value compared with 1933. Millstock includes all slate for structural and sanitary purposes, electrical products, blackboards, bulletin boards, school slates, billiard-table tops, and similar products. In consonance with the continued depression in construction, sales of structural slate in 1934 decreased sharply in both quantity and value. On the other hand, sales of electrical slate increased probably because of the relatively high output of electrical energy. Sales of slate for vaults and covers showed large decreases. The quantity of slate used for billiard-table tops has become insignificant, but the total quantity sold for flagging, walks, stepping stones, and similar products made a decided gain.

The following table gives the principal statistical data for the slate industry in 1933 and 1934; it is arranged to permit ready comparison of all products. Granules and flour, which have little connection with the industry, appear in the table because they are manufactured from slate; they are, however, properly a part of the crushed-stone industry and therefore are included also with other kinds of granules in the chapter of this volume on Crushed and Broken Stone.

Salient statistics of the slate industry in the United States, 1933–34

	1933			1934				
	Quantity		Value	Quantity		Value	Percent of change in—	
	Unit of measurement	Approximate equivalent short tons		Unit of measurement	Approximate equivalent short tons		Quantity (unit as reported)	Value
Domestic production (sales by producers):								
Roofing slate	*Squares* 153,170	57,920	$967,834	*Squares* 137,010	51,640	$1,033,164	−10.6	+6.8
Millstock:	*Sq. ft.*			*Sq. ft.*				
Electrical slate	190,540	1,700	132,295	201,710	1,800	147,280	+5.9	+11.3
Structural and sanitary slate	620,020	5,140	193,934	671,790	5,600	218,005	+8.3	+12.4
Grave vaults and covers	340,240	3,320	70,399	216,520	2,130	46,398	−36.4	−34.1
Blackboards and bulletin boards	625,950	1,500	113,667	698,780	1,680	163,983	+11.6	+44.3
Billiard-table tops	7,750	70	2,896	1,860	20	794	−76.0	−72.6
School slates	[1] 305,150	330	5,887	[1] 322,960	350	5,499	+5.8	−6.6
Total millstock	2,089,650	12,060	519,078	2,113,620	11,580	581,959	+1.1	+12.1
Flagstones, etc.[2]	354,160	3,260	28,951	399,430	3,350	26,705	+12.8	−7.8
Total slate as dimension stone		73,240	1,515,863		66,570	1,641,828	−9.1	+8.3
Granules and "flour"		186,380	1,180,322		166,160	1,066,100	−10.8	−9.7
Grand total domestic production		259,620	2,696,185		232,730	2,707,928	−10.4	+.4
Foreign trade:								
Imports for consumption			9,688			12,639		+30.5
Exports:								
Roofing	*Squares* 1,155		7,244	*Squares* 1,128		9,851	−2.3	+36.0
Other dimension slate			[3] 18,798			[3] 37,113		+97.4
Granules and "flour"		[3] 5,873	[3] 41,076		[3] 6,399	[3] 43,414	+9.0	+5.7

[1] Reported as pieces: 1933, 559,380; 1934, 603,668; square feet approximate.
[2] Includes walkways, stepping stones, and miscellaneous slate.
[3] Collected by the Bureau of Mines from shippers.

The following table shows sales of dimension slate by producers in recent years.

Slate (other than granules and flour) sold by producers in the United States, 1920–34

Year	Roofing			Millstock		Other [1]		Total	
	Squares	Approximate equivalent short tons	Value	Approximate short tons	Value	Approximate short tons	Value	Approximate short tons	Value
1920–29 (average)	457,492	159,872	$4,544,738	54,730	$3,590,070	7,398	$72,674	222,000	$8,207,482
1930	340,140	127,080	3,359,939	40,120	2,755,530	6,710	100,732	173,910	6,216,201
1931	277,700	103,210	2,364,861	29,440	1,754,054	5,790	66,904	138,440	4,185,819
1932	144,410	56,140	1,072,255	16,170	810,443	2,180	23,786	74,490	1,906,484
1933	153,170	57,920	967,834	12,060	519,078	3,260	28,951	73,240	1,515,863
1934	137,010	51,640	1,033,164	11,580	581,959	3,350	26,705	66,570	1,641,828

[1] Includes flagstones, walkways, stepping stones, and miscellaneous slate.

Figure 88 compares sales of slate, except granules and flour, from 1925 to 1934, with contracts awarded for residential building and total

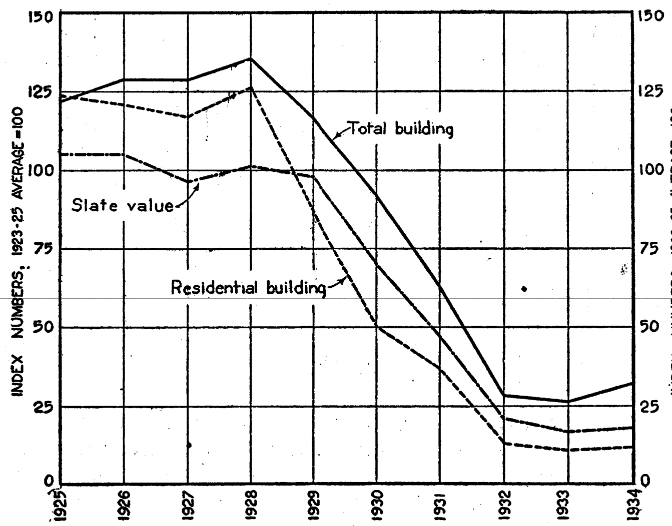

FIGURE 88.—Sales of slate compared with residential building and total building, 1925–34. Statistics for slate are from the Bureau of Mines; those for building were compiled by the F. W. Dodge Corporation.

building during the same period. The diagram illustrates the close relation between activity in the slate and construction industries. Although sales still are relatively low, the definite upward trend, though slow, is encouraging.

The following table shows slate granules and flour sold by producers from 1930 to 1934.

Crushed slate (granules and flour) sold by producers in the United States, 1930–34

Year	Granules		Flour		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1930	255,070	$1,549,301	34,630	$146,116	289,700	$1,695,417
1931	198,450	1,182,684	31,530	129,833	229,980	1,312,517
1932	174,140	1,058,713	35,610	139,103	209,750	1,197,816
1933	146,880	1,024,917	39,500	155,405	186,380	1,180,322
1934	123,290	902,078	42,870	164,022	166,160	1,066,100

Indicators of current activity.—In the belief that slate producers would welcome means of judging recent trends in their own and related industries the Bureau of Mines has sought available figures that might be used as indicators of current activity. The United States

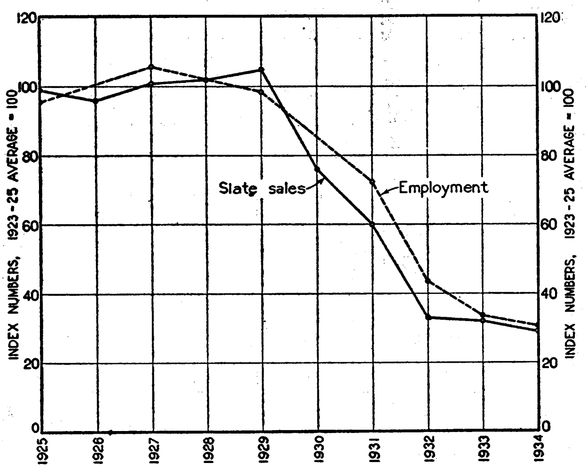

FIGURE 89.—Employment in the dimension-stone and slate industries compared with quantity of slate sold, 1925–34. To facilitate comparison of unlike units all data have been reduced to percentages of the 1923–25 averages. Data on employment are from the Bureau of Labor Statistics.

Bureau of Labor Statistics compiles monthly a series of index numbers indicating the condition of employment and pay rolls in certain industries compared with average conditions in those industries during the period 1923–25. These figures are available within 30 days after the end of the month they cover.

One group for which such indexes are computed is designated "Marble, granite, slate, and other stone products"; it includes mills for finishing dimension stone (building and monumental) and slate. Although slate is only one unit of this group, all the materials included are used primarily in construction and their trends are similar. The condition of employment in this group therefore should correspond approximately with the quantity of slate produced; likewise, the pay rolls should bear a somewhat definite relation to the value of sales. Exact correlation, of course, is not to be expected because of varying labor conditions. For example, wage rates have changed, particularly since codes have become effective, and spread of work on a part-time basis has given employment to relatively large numbers of workers compared with the actual man-hours of labor.

Figure 89 shows the relation between quantity of slate sold and average annual employment in the dimension-stone and slate industries from 1924 to 1934 and figure 90 the relation of value of slate sold to average annual pay rolls.

The similarity of the curves indicates that the indexes of employment and pay rolls compiled by the Bureau of Labor Statistics may be used to estimate slate production. Thus, a curve plotted from these indexes for part of 1935 compared with curves for previous years would show relative trends and indicate roughly the production for the entire year. Although figures obtained by this method would be only approximate, they probably would be accurate enough to assist the slate industry in planning activities and estimating the scope of future operations.

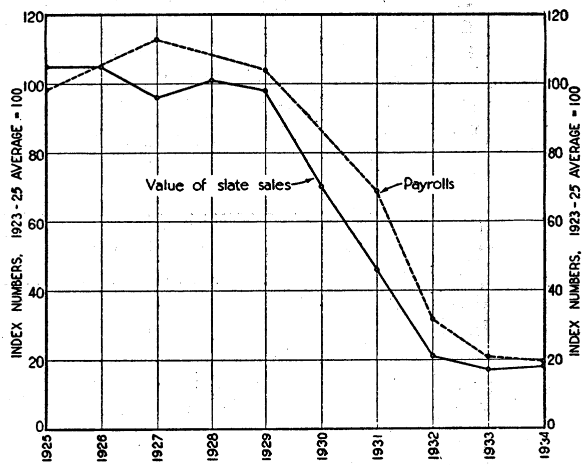

FIGURE 90.—Pay rolls in the dimension-stone and slate industries compared with value of slate sold, 1925–34. To facilitate comparison of unlike units all data have been reduced to percentages of the 1923–25 averages. Data on pay rolls are from the Bureau of Labor Statistics.

The following table shows indexes of employment and pay rolls in the dimension-stone and slate group for 1934 and part of 1935, by months. In the early months of 1935 a lower level was reached than in corresponding periods of 1934, but recovery was more rapid.

Indexes of employment and pay rolls in the marble, granite, slate, and other stone-products industries in the United States, January 1934–April 1935 [1]

Year	Employment	Pay rolls	Year	Employment	Pay rolls
1934			1934—Continued		
January	30.6	15.6	October	29.7	18.6
February	27.7	16.5	November	28.6	17.3
March	29.6	18.9	December	25.2	15.1
April	32.3	21.5			
May	34.6	24.9	1935		
June	33.8	22.8	January	20.0	11.0
July	33.1	21.5	February	22.6	14.4
August	31.3	20.1	March	23.4	15.2
September	32.2	20.2	April	26.5	18.2

[1] Compiled by the Bureau of Labor Statistics.

New developments.—In Europe waste slate is now used successfully in the manufacture of ceramic ware.[1] Slate flour with a high iron oxide and alkali content is suitable as a constituent material for paving bricks and stoneware pipes, and that having a high content of alumina is used in refractories. Slate containing large amounts of mica and pyrite is unsuitable for commercial use. Waste is used also to some extent in paint, as coloring for cement and cast-stone products, and in heat- and electrical-insulating materials.

Results of tests by the Department of Scientific and Industrial Research in England [2] on accelerated-weathering properties of slate corroborate the findings of the National Bureau of Standards.[3] The tests establish a means of classifying slates on the basis of their weather resistance.

Progress under the code.—A code of fair practice for the slate industry became effective January 22, 1934. Slate producers have suffered severely from price cutting, and the open-price policy provided in the code was designed to correct this condition; in 1934 the average unit values of nearly all slate products sold increased. Efforts are being made by the industry to establish a better cost-accounting system as an aid to producers in determining fair prices.

REVIEW BY DISTRICTS

The active slate-producing districts of the United States are: The Monson (Maine) district; the New York-Vermont district, including Washington County, N. Y., and Rutland County, Vt.; the Lehigh district, including Lehigh and Northampton Counties, Pa.; the Peach Bottom district, including York County, Pa., and Harford County, Md.; Berks County, Pa.; and the Buckingham County (Arvonia) and Albemarle County districts of Virginia. All these districts produce roofing slate and millstock, and some also produce roofing granules and slate flour. In addition, slate was produced during 1934 in Arkansas, California, Georgia, and Tennessee.

Occurrences of slate in the United States and in foreign countries and methods of quarrying and milling are described in a recent book.[4]

The following table shows sales of slate in 1934, by States and uses.

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[1] Stein-Industrie, vol. 28 (13), 1933, pp. 163–166.

[2] Watkins, C. M., The Durability of Slates for Roofing: Dept. Sci. and Ind. Research, Building Research Bull. 12, London, 1934.

[3] Kessler, D. W., and Sligh, W. H., Physical Properties and Weathering Characteristics of Slate: Nat. Bur. of Standards Research Paper 477, 1932.

[4] Bowles, Oliver, The Stone Industries: McGraw-Hill Book Co., Inc., 1934, 519 pp.

Slate sold by producers in the United States in 1934, by States and uses

State	Operators	Roofing: Squares (100 square feet)	Roofing: Value	Millstock: Square feet	Millstock: Value	Other uses [1] (value)	Total value
Arkansas	1					(2)	(2)
California	4					$35,393	$35,393
Georgia	1					(2)	(2)
Maine	3	3,580	$32,034	131,840	$101,801		133,835
Maryland	1					(2)	(2)
New York	20	4,760	41,733	2,500	750	263,386	305,869
Pennsylvania [3]	34	84,690	585,973	1,838,260	405,370	246,134	1,237,477
Tennessee	1	10	121	1,360	298	1,819	2,238
Vermont	49	30,220	260,268	139,660	73,740	245,574	579,582
Virginia	6	13,750	113,035			(2)	(2)
Undistributed [4]						300,499	413,534
Total, 1934	120	137,010	1,033,164	2,113,620	581,959	1,092,805	2,707,928
Total, 1933	123	153,170	967,834	2,089,650	519,078	1,209,273	2,696,185

[1] Flagging and similar products, granules, and flour.
[2] Included under "Undistributed."
[3] For detailed table for Pennsylvania see p. 928.
[4] Includes output of States entered as (2) above.

Maine.—Slate produced in Maine is sold chiefly for electrical slabs; smaller quantities are sold for roofing and structural purposes. Sales of both roofing and electrical slate made substantial gains in 1934 compared with 1933, the value increasing relatively much more than the quantity.

New York-Vermont.—The slate deposits of New York are continuous with those of Vermont, and this district provides all the colored roofing slate now used in the United States.

The New York quarries furnish an attractive unfading red, as well as sea-green, unfading green, purple, and variegated slate. The products are granules and flour (red), roofing slate, millstock, and slabs for walks, flagging, and similar purposes. The quantity and value of roofing slate sold in 1934 were nearly three times those in 1933; other products except millstock, however, showed marked declines, and the value of total sales for the State was only 5 percent greater than in 1933.

The Vermont quarries provide, in addition to the black and gray types common in other slate districts of the United States, a great variety of green, purple, and mottled slates that are well adapted for ornamental roofing and command relatively high prices. They also produce millstock for structural, sanitary, and electrical uses; flagging; granules, chiefly from the green slate; and slate flour. Many thick, heavy roofing slabs of variegated and "freak" colors are sold under the name "architectural."

In Vermont, as in New York, much of the roofing slate is quarried and shaped by owners of small quarries worked at irregular intervals and is sold either through dealers or to operators of the larger quarries. Production of slabs for walks, stepping stones, and porch floors is becoming increasingly important.

In 1934 sales of Vermont roofing slate decreased 25 percent in quantity and 12 percent in value, millstock 17 percent in quantity and 13 percent in value, and the value for all products nearly 16 percent compared with 1933. Vermont is the only dimension-slate producing State that failed to show an increase in value of output in 1934.

Peach Bottom district.—The Peach Bottom district—near Delta, Pa., and Cardiff, Md.—furnishes high-grade blue-black roofing slate but in recent years has produced very small quantities. Two large plants, one in Maryland and one in Pennsylvania, produce granules and slate flour.

Lehigh district.—The Lehigh district, comprising Lehigh and Northampton Counties, Pa., is the most productive slate area in the United States. The products include roofing, structural, sanitary, and electrical slate, blackboards, school slates, flagging, granules, and slate flour.

The following table shows sales of dimension slate in the Lehigh district in 1934, by counties and uses; it includes also the output of granules and flour in the Lehigh district and in Berks and York Counties.

Slate sold by producers in Pennsylvania in 1934, by counties and uses

County	Operators	Roofing slate		Millstock [1]			
				Electrical		Structural and sanitary [2]	
		Squares (100 square feet)	Value	Square feet	Value	Square feet	Value
Lehigh	13	10,500	$69,887	32,690	$16,328	37,350	$7,164
Berks, Northampton, and York [3]	21	74,190	516,086	3,890	2,694	740,780	208,922
Total, 1934	34	84,690	585,973	36,580	19,022	778,130	216,086
Total, 1933	37	95,050	537,178	38,850	18,670	821,790	203,934

County	Millstock—Continued				Other (value) [4]	Total value
	Blackboards and bulletin boards		School slates			
	Square feet	Value	Square feet	Value		
Lehigh	309,580	$74,844	322,960	$5,499	$108	$173,830
Berks, Northampton, and York [3]	389,150	89,125			246,820	1,063,647
Total, 1934	698,730	163,969	322,960	5,499	246,928	1,237,477
Total, 1933	625,950	113,667	305,150	5,887	244,678	1,124,014

[1] Exclusive of billiard-table material, value for which is included under "Other."
[2] Includes slate for grave covers and vaults.
[3] Berks and York Counties produced roofing granules and flour only.
[4] Includes billiard-table material, as follows: 1933, 7,560 square feet, valued at $2,842; 1934, 1,860 square feet, valued at $794.

The quarries in the Lehigh district are chiefly in the vicinity of Bangor, Pen Argyl, Windgap, Chapman Quarries, Berlinsville, Slatington, and Slatedale. The slate is of two principal types—hard vein and soft vein. The hard vein is used almost exclusively for roofing; a small output of flagstones is reported at times. The soft vein is used for both roofing and millstock; it is particularly well-adapted for blackboards. This small territory is the most important source of slate blackboards in the world.

Sales of roofing, electrical, structural, and sanitary slate decreased in quantity but increased in value in 1934 compared with 1933; those of blackboards and bulletin boards increased in both quantity and value. The value of total sales in Pennsylvania increased 10 percent.

Virginia.—The principal slate-producing district of Virginia is near Arvonia and Ore Bank, Buckingham County. The material is used for roofing almost exclusively, as it is too hard to shape into other products. In normal times four companies operate in this territory. Sales of roofing slate in 1934 increased 16 percent in quantity and 34 percent in value compared with 1933. At times roofing slate is produced near Dutch Gap, Buckingham County, and Esmont and Monticello, Albemarle County. There are granule mills at Esmont and Dutch Gap.

Other districts.—In Arkansas a slate deposit near Mena, Polk County, was worked in 1934 for the manufacture of granules. Development work was done on a property near Norman, Montgomery County, with a view to starting commercial operations in 1935; according to report the slate is mottled black and gray or black and yellow, and some material for walks and flagging has been shipped.

In California small quantities of red slate quarried about 5 miles from Keeler, Inyo County, were used in the manufacture of granules; the fines are used satisfactorily as asphalt filler. The Pacific Chili-Bar quarry near Placerville, Eldorado County, produced granules and flour. Sales of granules were reported also from Ventura County (near Saugus), and from near Hetch Hetchy Junction, Tuolumne County.

In Georgia green slate for granules and flour was produced in Bartow County near Fair Mount.

In Tennessee green and purple slates for roofing, millstock, and walks were quarried near Chilhowee, Blount County.

SLATE IN GREAT BRITAIN

Slate evidently is used much more widely as a roofing material in Great Britain than in the United States, for the industry is much larger in that country than in America and has recovered more rapidly from the depression. Stimulated by extensive construction of dwellings, most of the quarries are operating at full capacity. During the summer of 1934 the Dinorwic quarries of Wales employed 2,000 workers. Official returns for 1933 show a total production of 207,600 long tons; of this quantity 147,915 tons were from North Wales and northwestern England, 874 tons from Swansea, 21,341 tons from the Midlands and southern England, 17,037 tons from northern England, and 20,413 tons from Scotland.[5]

FOREIGN TRADE [6]

Imports.—The value of slate imported for consumption in the United States increased 30 percent in 1934 compared with 1933. The following table shows the total value of imports from 1929 to 1934.

[5] U. S. Bureau of Foreign and Domestic Commerce, Foreign Trade Notes—Minerals and Metals: Vol. 2, Nov. 27, 1934, p. 10.

[6] Figures on imports and exports (unless otherwise indicated) compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Value of slate imported for consumption in the United States, 1929–34

Year	Value	Year	Value
1929	$95,073	1932	$17,317
1930	48,065	1933	9,688
1931	46,581	1934	12,639

The following table shows the value of imports in 1933 and 1934, by countries. The increase in 1934 was due to unusually large receipts from the Netherlands. Presumably the material originated in Belgium, Luxemburg, or France, for the Bureau of Mines has no record of a slate-quarrying industry in the Netherlands.

Value of slate (manufactured)[1] imported into the United States, 1933–34, by countries

Country	1933	1934	Country	1933	1934
Albania	$382		Netherlands	$111	$6,139
Canada	390	$1,867	Sweden	2,186	
Czechoslovakia	4,129	2,345	Switzerland	135	
Danzig and Poland	157		United Kingdom		84
Germany	2,024	1,604	Yugoslavia	43	
Hong Kong	19	24		9,688	12,639
Italy	93	540			
Japan	19	36			

[1] No imports of roofing slate reported since 1932.

Exports.—The following table shows total exports of roofing slate from 1929 to 1934. Exports decreased 2 percent in quantity but increased 36 percent in value in 1934 compared with 1933. The marked increase in average value per square from $6.27 to $8.73 reflects the general elevation in price levels.

Roofing slate exported from the United States, 1929–34

Year	Number of squares	Value	Year	Number of squares	Value
1929	10,376	$121,367	1932	1,792	$12,215
1930	5,278	64,343	1933	1,155	7,244
1931	4,174	45,020	1934	1,128	9,851

The following table shows exports of roofing slate from 1932 to 1934, by countries. Exports to countries other than Canada have become very small.

Roofing slate exported from the United States, 1932–34, by countries

Country	1932		1933		1934	
	Number of squares	Value	Number of squares	Value	Number of squares	Value
Bermudas	4	$75				
Canada	1,487	11,124	906	$5,498	1,108	$9,672
Mexico	[1] 242	[1] 320	7	35	15	140
New Zealand	59	696				
West Indies:						
Trinidad and Tobago			242	1,711		
Other British					5	39
	1,792	12,215	1,155	7,244	1,128	9,851

[1] Reported as "surfaced roofing."

The following table shows exports of slate other than roofing from 1932 to 1934. The value of exports of millstock in 1934 was almost double that in 1933. The substantial increase in exports of school slates, blackboards, and structural slate is encouraging; however, exports of electrical slate have decreased greatly.

Slate other than roofing exported from the United States, 1932–34, by uses [1]

Use	1932		1933		1934	
	Quantity	Value	Quantity	Value	Quantity	Value
School slates.....cases [2]	2,886	$17,975	1,302	$10,167	3,686	$25,028
Electrical slate.....square feet	780	777	1,800	2,000	114	205
Blackboards.....do	55,394	16,978	28,187	5,791	37,342	10,425
Billiard tables.....do	13,214	6,128	500	229	489	230
Structural.....do	2,499	1,100	1,462	611	2,985	1,225
Slate granules and flour.....short tons	(3)	(3)	5,873	41,076	6,399	43,414
	....	[3] 42,958	....	59,874	....	80,527

[1] Collected by Bureau of Mines from shippers of products named.
[2] Cases weigh 130 to 165 pounds each; average is 135 pounds.
[3] Figures for granules and flour not available.

CRUSHED AND BROKEN STONE [1]

By Carl Gnam and A. T. Coons

SUMMARY OUTLINE

Preliminary figures indicate that the downward trend in total sales of crushed and broken stone during the past 4 years was halted in 1934. Sales in 1934—110,449,613 short tons—represented an increase of 23 percent over the 89,952,950 short tons sold in 1933. This percentage increase is identical with the rise in building construction indicated by the value of contracts awarded but apparently is greater than the rise in highway and road construction, because concrete-pavement contract awards, cement shipments, and asphalt sales increased less than the output of crushed stone. Demand for crushed stone apparently has held up better during the last few years than that for other building materials; taking the 3-year average for 1923–25 as 100, the index of crushed stone production stood at 60 in 1933 and 73 in 1934 compared with the general building-construction index, which was 27 in 1933 and 32 in 1934. The Federal Reserve Board index of industrial activity advanced from 76 in 1933 to 79 in 1934.

The following table of salient statistics shows the quantity and value of crushed and broken stone sold during 1933 and 1934 by uses. No value is given to stone used in cement and lime manufacture, as virtually all of it is produced by manufacturers for their own use. Detailed data on asphaltic stone and slate granules and flour are given in the chapters on asphalt and on slate.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

Salient statistics on crushed and broken stone sold or used by producers in the United States, 1933–34, by principal uses

Use	1933			1934 [1]			Percent of change in 1934	
	Short tons	Value		Short tons	Value		Tonnage	Value per ton
		Total	Average per ton		Total	Average per ton		
Concrete and road metal	40,857,120	$35,843,318	$0.88	52,650,000	$50,730,000	$0.96	+29	+9
Railroad ballast	4,633,490	3,175,418	.69	4,956,000	3,865,000	.78	+7	+13
Metallurgical	7,984,710	5,512,533	.69	9,013,000	6,166,000	.68	+13	−1
Alkali works	4,193,650	2,120,908	.51	3,814,000	2,016,000	.53	−9	+4
Riprap	3,254,860	3,486,155	1.07	4,834,000	4,754,000	.98	+49	−8
Agricultural limestone	994,540	1,239,724	1.25	1,580,000	1,627,000	1.03	+59	−18
Refractory (ganister, mica schist, dolomite)	501,440	710,526	1.42	673,000	772,000	1.15	+34	−19
Asphalt filler	126,780	332,159	2.62	165,000	330,000	2.00	+30	−24
Calcium carbide	117,740	75,077	.64	306,000	178,000	.58	+160	−9
Sugar factories	607,990	887,630	1.46	487,000	674,000	1.38	−20	−5
Glass factories	199,720	245,835	1.23	159,000	257,000	1.62	−20	+32
Paper mills	196,440	285,850	1.46	256,000	345,000	1.35	+30	−8
Asphaltic stone	285,070	1,125,164	3.95	410,453	1,762,376	4.29	+44	+9
Slate granules and flour	186,380	1,180,322	6.33	166,160	1,066,100	6.42	−11	+1
Other uses [2]	5,246,020	4,846,515	.92	6,450,000	6,002,000	.93	+23	+1
Total	69,385,950	61,067,134	.88	85,919,613	80,544,476	.94	+24	+7
Portland and natural cement (including "cement rock") [3]	16,117,000			19,730,000			+22	
Lime [4]	4,450,000			4,800,000			+8	
Total stone	89,952,950			110,449,613			+23	

[1] Subject to revision.
[2] Includes uncrushed field stone used in Pennsylvania for road base: 1933 about 4,127,380 short tons valued at $2,546,335; 1934 about 4,538,400 short tons valued at $3,157,900.
[3] Value reported as cement in chapter on cement.
[4] Value reported as lime in chapter on lime.

Production of crushed stone reached a peak in 1929, dropped sharply from 1930 to 1933, and increased moderately in 1934. (See fig. 91.)

Markets.—The advance in sales of stone for concrete and road metal, which usually constitute over half the sales of all commercial crushed stone, agrees with the greater sales of paving asphalt, cut-back asphalt, and road oil in 1934. The gains over 1933 were 16 percent for paving asphalt and 23 percent for both cut-back asphalt and road oil. Concrete pavement contract awards compiled by the Portland Cement Association remained virtually the same in 1934 as in 1933, but cement shipments in 1934 exceeded those in 1933 by 18 percent. Sales of crushed stone for concrete and road metal held up better in 1933 and 1934 than either cement shipments or concrete-pavement contract awards, apparently reflecting increased use of stone in bituminous and low-type road construction. (See fig. 92.)

The value of construction contracts reported by the F. W. Dodge Corporation in 1934 increased 23 percent compared with 1933. Engineering-construction contract awards were 27 percent higher in 1934 than in 1933. Greater use of riprap in 1934 probably was the result of improvements to harbors and rivers and construction of dams, mainly by Government agencies.

Expenditures for ballast by class I railroads obtained through the courtesy of the Bureau of Railway Economics were about 23 percent

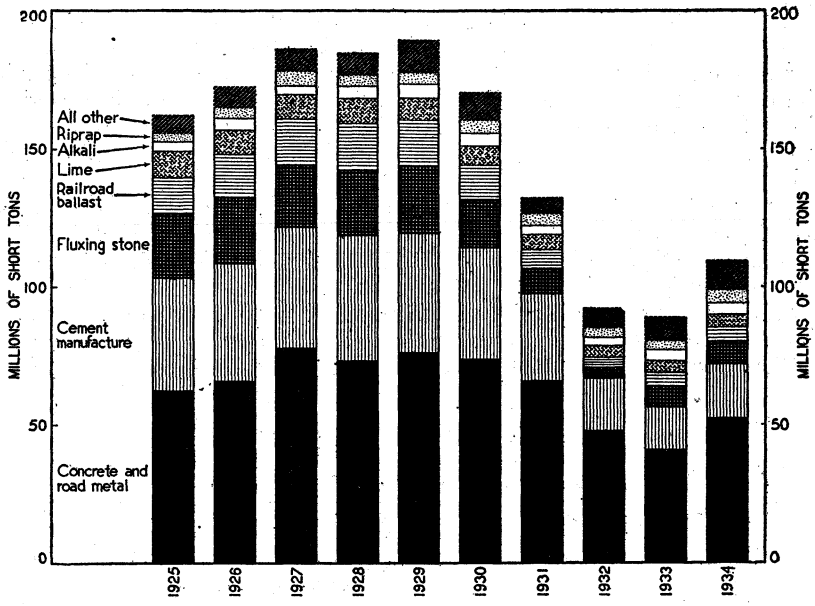

FIGURE 91.—Crushed stone sold or used by producers in the United States, 1925–34, by principal uses. Figures for 1934 are subject to revision.

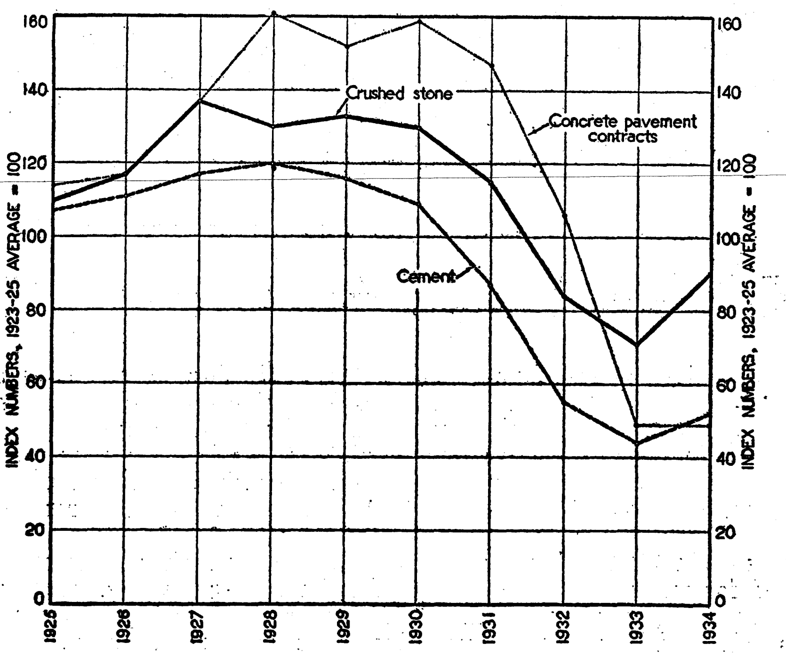

FIGURE 92.—Sales of crushed stone for concrete and road metal compared with cement shipments and concrete pavement contract awards, 1925–34. All data are plotted as index numbers with the 1923–25 average as 100. Figures for 1934 are subject to revision. Statistics on concrete pavement contract awards compiled by Portland Cement Association.

greater in 1934 than in 1933, which checks closely the increase of 22 percent in value of crushed stone sold for ballast.

Sales of fluxing stone and refractory stone, consumed principally by the iron and steel industry, increased in 1934 with the rising production of pig iron and steel ingot. Fluctuations in output of fluxing stone and pig iron correspond closely, and a definite relationship also exists between refractory-stone output and steel-ingot production. (See fig. 93.) The sharp rise in the index of refractory stone in the last 2 years can be attributed to extensive repairs and replacements to open-hearth furnaces necessitated by their deterioration during the low-production periods of 1931 and 1932.

Sales to alkali works in 1934 dropped slightly from the 1933 quantity—the largest since 1930. Sales of 1,580,000 short tons of agricultural limestone in 1934 represented an increase of 59 percent from

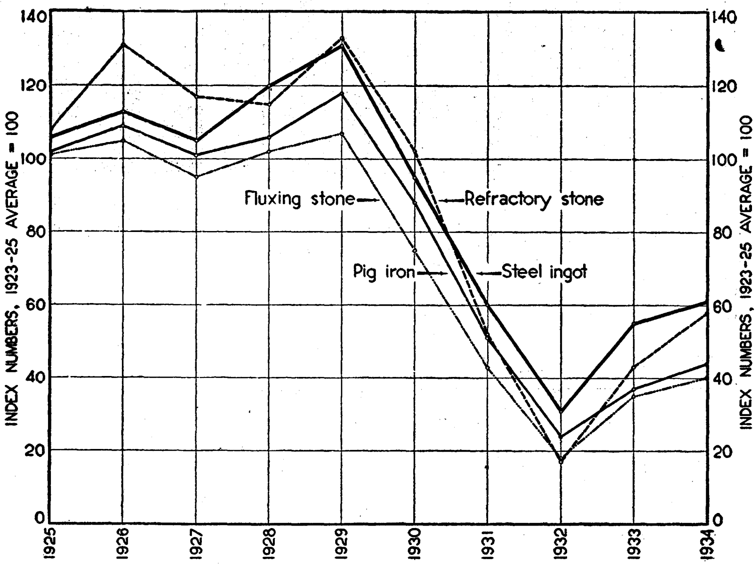

Figure 93.—Sales of fluxing stone and refractory stone compared with production of steel ingot and pig iron, 1925–34. All data are plotted as index numbers with the 1923–25 average as 100, and figures for 1934 are subject to revision. Statistics on steel-ingot and pig-iron production compiled by American Iron and Steel Institute.

1933, which apparently reflects greater purchasing power on the part of the farmer. The rest of the uses for which crushed stone is sold account for only a small proportion of the total production, but a general increase is indicated by partial returns from producers.

Prices.—The average value per ton of crushed and broken stone increased from $0.88 in 1933 to $0.94 in 1934, the first gain registered since 1926, when the comparable value was $1.08 per ton. The increase in 1934 is due for the most part to the higher value of stone used for concrete and road metal, for the average value of stone sold for several other uses declined. In general, prices of crushed stone as indicated by values reported by producers, have been maintained at a relatively higher level than wholesale prices of either building materials or all commodities. (See fig. 94.)

Employment and output per man.—Production and employment data collected by the Bureau of Mines in its studies of accident statistics were obtained for 188 commercial crushed-stone plants operating in 26 States during 1933 and 1934 and are presented in the following table. Selection of the material was based on the necessity of choosing plants which furnished complete returns in both years, so it does not follow that conditions at these plants represented a fair sample of the industry as a whole. For example, these establishments probably were of a more permanent nature than those that failed to report production in either year and it is likely that part of the gain in sales during 1934 came from plants that were idle in 1933.

Production figures for these plants decreased slightly in 1934 compared with 1933—2.1 percent—whereas the national total rose 23 percent. Hours per day were identical in both years, but the number of men employed increased from 8,377 in 1933 to 8,597 in 1934, and

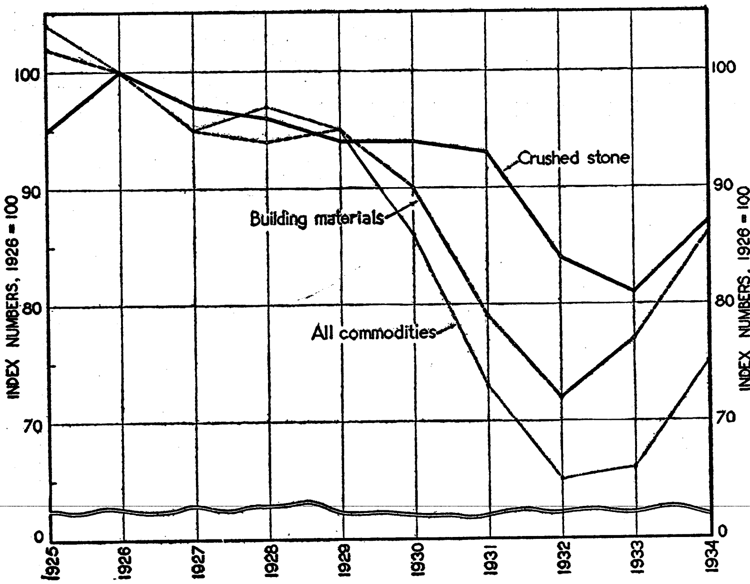

FIGURE 94.—Average value of crushed stone compared with wholesale prices of building materials and all commodities, 1925–34. All data are plotted as index numbers with 1926 as 100. The value of crushed stone in 1934 is subject to revision. Price indexes for building materials and all commodities compiled by Bureau of Labor Statistics.

the number of days worked advanced from 180 to 192—the result in part, at least, of compliance to the N. R. A. code [2] that became effective in the latter part of 1933. The somewhat lower output per plant (101,797 short tons in 1933 and 99,617 short tons in 1934) and the marked reduction of 10.2 percent in average output per man-shift (12.7 short tons in 1933 and 11.4 short tons in 1934) cannot be explained so readily. A natural conclusion is that general efficiency fell, possibly because of lack of experience on the part of new men who were employed. However, it may be that the additional employees were engaged in stripping, plant improvements, or other nonproductive activities that had been postponed during the previous year when sentiment in the industry was at too low an ebb to encourage undertaking any expenditures that were not absolutely needed in connection with current production.

[2] Developments under the code are discussed in the chapter on Sand and Gravel.

Employment at 188 crushed stone plants, quantity of stone produced, and average output per man, 1933–34

Year	Employment					Production			Percent of industry represented[1]
	Average number of men	Time employed				Crushed stone (short tons)	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1933	8,377	180	1,507,281	7.8	11,732,701	19,137,918	12.7	1.6	28
1934	8,597	192	1,649,357	7.8	12,943,039	18,727,945	11.4	1.4	22

[1] Calculated for each year by dividing the quantity of stone produced at plants included in study by the total quantity sold or used by producers, exclusive of lime and cement manufacture.

SAND AND GRAVEL [1]

By H. H. Hughes and M. Allan

SUMMARY OUTLINE

The increase in construction in 1934 was reflected in an advance of about 14 percent in the output of commercial sand and gravel opera-

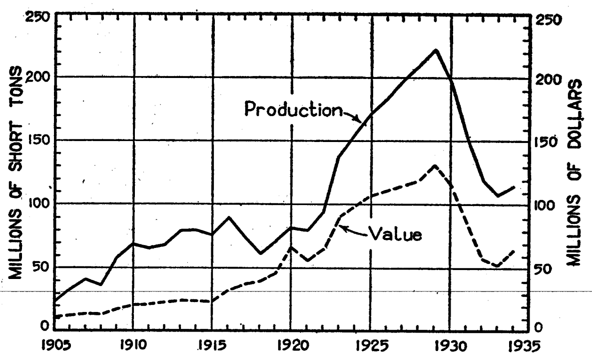

FIGURE 95.—Principal trends in the sand and gravel industry, 1905–34.

tions. Activity in local road-building projects, however, apparently slumped during the year, as preliminary returns show a decline in the production of sand and gravel reported by States, counties, municipalities, and other Government agencies. Available data on consuming markets and partial returns from producers indicate that the total output of sand and gravel in 1934 was about 113,000,000 short tons, valued at approximately $65,000,000. The sharp decline since 1929 in both production and value was definitely arrested by the upturn in 1934. (See fig. 95.)

Sales of sand and gravel for virtually all uses increased in 1934 compared with 1933. Molding sand and fire and furnace sand reflected activity in the steel industry, with advances of 30 and 41 percent, respectively. Increased output of building and paving sand

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

and gravel accounted for most of the advance in total commercial production. Values also were higher in 1934 than in 1933. The average value of all sand advanced from $0.61 a ton in 1933 to $0.69 in 1934; that of gravel increased from $0.59 to $0.64. Salient statistics of the sand and gravel industry in 1933 and preliminary figures for 1934 are summarized in the following table:

Sand and gravel sold or used by producers in the United States, 1933–34, by commercial and noncommercial operations, and by uses

	1933		1934 [1]			
					Percent of change	
	Short tons	Value per ton	Short tons	Value per ton	Tonnage	Value per ton
COMMERCIAL OPERATIONS						
Sand:						
Glass	1,781,423	$1.69	1,920,000	$1.75	+8	+4
Molding	1,718,251	.91	2,240,000	.95	+30	+4
Building	13,024,174	.50	16,400,000	.56	+26	+12
Paving	10,903,447	.51	11,500,000	.57	+5	+12
Grinding and polishing	572,735	1.29	580,000	1.75	+1	+36
Fire or furnace	106,133	1.14	150,000	1.55	+41	+36
Engine	1,051,695	.59	1,250,000	.75	+19	+27
Filter	24,387	2.14	35,000	2.00	+44	−7
Railroad ballast [2]	721,381	.27	650,000	.31	−10	+15
Other	1,121,271	.45	775,000	.80	−31	+78
Total sand	31,024,897	.61	35,500,000	.69	+14	+13
Gravel:						
Building	11,934,080	.68	14,500,000	.67	+22	−1
Paving	17,719,859	.59	19,500,000	.68	+10	+15
Railroad ballast [3]	4,928,031	.36	5,500,000	.41	+12	+14
Other [4]	499,605	.58	500,000	.50		−14
Total gravel	35,081,575	.59	40,000,000	.64	+14	+8
Total sand and gravel	66,106,472	.60	75,500,000	.66	+14	+10
NONCOMMERCIAL OPERATIONS [5]						
Total sand and gravel	41,648,877	.33	37,500,000	.40	−10	+21
COMMERCIAL AND NONCOMMERCIAL OPERATIONS						
Grand total	107,755,349	.49	113,000,000	.57	+5	+16

[1] Figures subject to revision.
[2] Includes some sand used for fills and similar purposes. The quantity of sand reported as used exclusively for ballast in 1933 was 550,948 short tons valued at $160,576 (revised figures). The figures include sand produced by railroads for their own use in 1933 as follows: Ballast, 50,811 short tons valued at $7,694; fills and similar purposes, 170,433 short tons valued at $32,577.
[3] Includes some gravel used for fills and similar purposes. The quantity of gravel reported as used exclusively for ballast in 1933 was 4,668,597 short tons valued at $1,747,452. The figures include gravel produced by railroads for their own use in 1933 as follows: Ballast, 1,232,795 short tons valued at $247,522; fills and similar purposes, 259,434 short tons valued at $29,711.
[4] May include some gravel used by railroads for fills and miscellaneous purposes.
[5] By States, counties, municipalities, and other Government agencies, directly or under lease.

Since 1925 gravel has become increasingly important in total sand and gravel output. (See fig. 96.) Gravel comprised only 49 percent and sand 51 percent of the total in 1925. In 1933, however, sales of gravel were 69 percent of the total and sales of sand only 31 percent. Preliminary figures for 1934 indicate that gravel comprised 67 percent of the total sand and gravel output and sand 33 percent.

Noncommercial production.—Since 1932 statistics of the sand and gravel industry have been broken down to show production by commercial and by noncommercial operations—States, counties, municipalities, and other Government agencies. Noncommercial producers in 1933 reported a total output of 41,648,877 short tons of sand and gravel, with an average value of $0.33 a ton. New England and States west of the Mississippi contributed about four-fifths of the total.[2] State highway departments or comparable State officials reported 57 percent of the total noncommercial tonnage, county authorities 37 percent, and municipalities and other Government agencies 3 percent each.

Only 13,645,409 short tons—about one-third—of the sand and gravel produced by noncommercial operations in 1933 was washed or screened to make it comparable in quality with the output of the average commercial plant. By far the larger part comprised pit-run material having a low unit value.

Complete statistics from noncommercial producers are not yet available, but partial returns for 1934 indicate a drop of about 10 percent in noncommercial output compared with 1933. An advance of about 21 percent in average value per ton is also indicated.

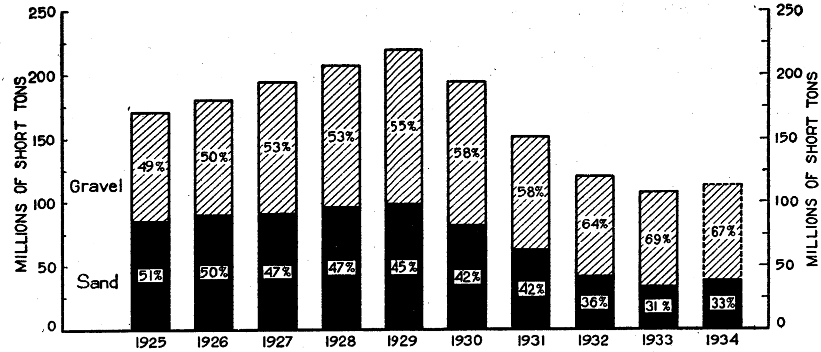

FIGURE 96.—Sand and gravel sold or used by producers in the United States, 1925–34, showing relative importance of each. Figures for 1934 are subject to revision.

Figure 97 shows sand and gravel sold or used by commercial and noncommercial producers from 1928 to 1934, inclusive.

In 1933 sand and gravel produced by noncommercial operations accounted for 39 percent of all material reported to the Bureau of Mines, but in 1934 the output of noncommercial plants represented only 33 percent of the total.

Employment and output per man.—In 1933 sand and gravel producers representing 71.4 percent of commercial production reported data on employment. This information included the average number of men employed during the year, the number of days the plant was operated, and the length of the working day.

Data summarized in the accompanying table cover only those plants from which returns were received; no estimates for missing companies have been included. The table is set up by regions to show the average number of men employed, total man-shifts, and total man-hours as calculated from data reported on the schedules. From these totals the average number of days in operation and the average number of hours per man per day have been computed for each region and for the United States. The quantity of sand and gravel produced at

[2] Pit and Quarry, vol. 27, no. 10, April 1935, p. 55.

plants included in the study is shown in the table, as well as the percentage of total commercial production represented. Finally, com-

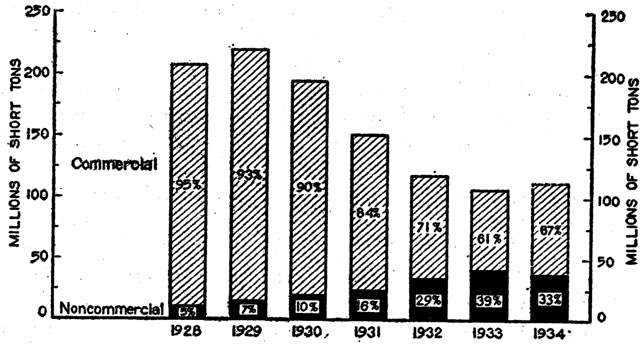

FIGURE 97.—Sand and gravel sold or used in the United States by commercial and noncommercial producers, 1928–34. Noncommercial producers include States, counties, municipalities, and other Government agencies. Figures for 1934 are subject to revision.

putations have been made to show the average output of sand and gravel per man-shift and per man-hour.

Employment in the commercial sand and gravel industry, sand and gravel produced at plants included in the study, and average output per man in the United States, 1933, by regions [1]

Region	Employment					Production			Percent of commercial industry represented
	Average number of men	Time employed				Commercial sand and gravel (short tons)	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1. Maine, New Hampshire, Vermont, Rhode Island, Massachusetts, and Connecticut	444	119	52,700	8.5	445,885	1,368,647	26.0	3.1	62.4
2. New York	924	148	136,976	8.4	1,152,555	3,269,825	23.9	2.8	51.8
3. Pennsylvania, New Jersey, and Delaware	1,662	173	287,861	9.1	2,610,856	5,138,909	17.9	2.0	78.6
4. West Virginia, Virginia, Maryland, and District of Columbia	834	269	224,481	8.4	1,880,521	3,001,665	13.4	1.6	71.3
5. South Carolina, Georgia, Alabama, Florida, and Mississippi	398	131	52,056	9.0	468,085	1,356,564	26.1	2.9	60.3
6. North Carolina, Kentucky, and Tennessee	488	149	72,650	8.6	626,044	1,417,047	19.5	2.3	65.9
7. Arkansas, Louisiana, and Texas	1,447	178	257,780	9.0	2,316,410	3,956,350	15.3	1.7	77.6
8. Ohio	1,049	167	175,326	8.5	1,495,915	3,025,132	17.3	2.0	84.0
9. Illinois and Indiana	1,498	152	228,353	9.3	2,120,751	7,694,970	33.7	3.6	86.0
10. Michigan and Wisconsin	955	108	102,885	9.3	952,461	4,239,434	41.2	4.5	86.2
11. North Dakota, South Dakota, and Minnesota	470	68	31,893	8.4	266,897	934,073	29.3	3.5	63.3
12. Nebraska and Iowa	609	121	73,527	8.1	593,810	2,317,021	31.5	3.9	78.0
13. Kansas, Missouri, and Oklahoma	909	147	133,666	8.1	1,076,263	3,579,755	26.8	3.3	84.6
14. Wyoming, Colorado, New Mexico, Utah, and Arizona	153	168	25,632	8.1	206,430	3,751,107	146.3	18.2	91.7
15. California and Nevada	308	159	48,998	8.0	391,666	1,220,148	24.9	3.1	24.5
16. Montana, Washington, Oregon, and Idaho	388	109	42,441	7.9	333,313	944,476	22.3	2.8	44.4
Total United States	12,536	155	1,947,225	8.7	16,937,862	47,215,123	24.2	2.8	71.4

[1] Does not include plants operated by or directly for States, counties, municipalities, and other Government agencies.

Altogether 12,536 men are represented in the detailed study which includes 71.4 percent of commercial production. If it is assumed that production at the remainder of the commercial plants was at approximately the same rate, then about 17,500 men were employed by the sand and gravel industry during some part of the year. The average number of days of employment throughout the year, however, was only 155, and the average shift was 8.7 hours.

The output of sand and gravel per man-hour ranged from 1.6 tons in region 4 and 1.7 tons in region 7 to 3.9 tons in region 12 and 4.5 tons in region 10. The figure of 18.2 tons per man-hour for region 14 is not comparable with that of other regions because it is weighted heavily by the highly mechanized sand and gravel operations at Boulder Dam.

Prices.—Complete data on the average value of sand and gravel produced in 1934 are not yet available, but preliminary figures based on partial returns from producers indicate a general increase over 1933. The average value of all sand accounted for increased 13 per-

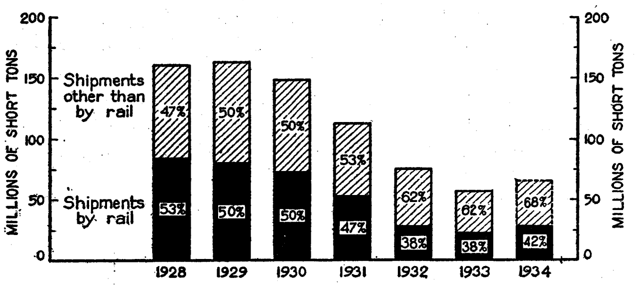

FIGURE 98.—Shipments of sand and gravel, by modes of transportation, 1928–34. Data on rail shipments are from reports of the Interstate Commerce Commission; to insure comparability, glass and molding sand, railroad ballast, and noncommercial production have been excluded from the figures used in the comparisons. Figures for 1934 are subject to revision.

cent (from $0.61 a ton in 1933 to $0.69 in 1934); that of gravel increased 8 percent (from $0.59 to $0.64). Wholesale-price statistics compiled by the Bureau of Labor Statistics show an advance of 13 percent in the price of building sand in 1934 compared with 1933 and 7 percent in the price of building gravel.

Apparently the average value of noncommercial production also increased—from $0.33 in 1933 to about $0.40 in 1934.

Rail and water shipments.—Shipments of sand and gravel on class I railroads in 1934 totaled 27,683,407 short tons, an advance of 27 percent over the 21,818,258 tons in 1933. This increase terminated an uninterrupted sharp decline since 1928. As preliminary figures of commercial production indicate an increase in output of only 14 percent, apparently the trend toward increased use of truck transportation was arrested. In 1932 and 1933 only 38 percent of commercial production, exclusive of glass and molding sand and nonrevenue railroad ballast, was shipped by rail, but in 1934 preliminary figures indicate that 42 percent was carried on class I roads. (See fig. 98.)

The upturn in rail shipments was fairly uniform over the entire country. The notable exception was the Southwestern region where shipments in 1934 dropped 1 percent from 1933. Elsewhere increases ranged from 16 percent in New England to 85 percent in the Northwestern region.

The quantity of sand and gravel shipped by barge on the Ohio and Monongahela Rivers in the Pittsburgh district increased 3 percent—from 1,540,480 short tons in 1933 to 1,581,410 short tons in 1934.

MARKETS

More than half the output of sand and gravel from commercial operations is used in concrete construction, either highways or buildings. Consumption of portland cement therefore provides a good indicator of demand for sand and gravel. Cement shipments in 1934 increased 18 percent over 1933, which checks closely the advance of 14 percent indicated by preliminary figures for commercial sand and gravel production. Shipments of paving asphalt, which also indicate demand for sand and gravel, increased 16 percent in 1934 compared with 1933.

Most of the output of noncommercial operations is unprepared pit-run material used locally in road construction. Preliminary returns indicate a drop of about 10 percent in the production of this type of material in 1934, but sales of road oil, which commonly is used also in low-type roads, ncreased 23 percent in 1934 compared with 1933.

Data relating to the production and consumption of sand and gravel are summarized in the following table. Additional statistics of the construction industry are included in the chapter on cement.

Summary of data relating to production and consumption of sand and gravel [1]

	1933	1934 [2]	Percent of change in 1934
Sand and gravel shipments:			
Rail shipments, class I roads [3] ... short tons	21,818,258	27,683,407	+27
Water shipments: Pittsburgh district [4] ... do	1,540,480	1,581,410	+3
Correlative industries:			
Portland-cement shipments ... barrels	64,282,756	75,917,000	+18
Paving-asphalt shipments ... short tons	798,607	924,135	+16
Cut-back asphalt shipments ... do	508,553	624,183	+23
Road-oil sales ... barrels	6,238,898	7,702,753	+23
Construction: [5]			
Concrete-pavement contract awards [6] ... square yards	45,128,000	45,108,000	----------
Construction contract awards [7]	$1,256,601,000	$1,543,842,000	+23
Railway expenditures, class I roads: For ballast [8]	$7,814,385	$8,855,000	+13
Glass production, monthly average:			
Glass containers (shipments) [9] ... gross	2,754,000	2,920,000	+6
Illuminating glassware [10] ... turns	1,387	1,517	+9
Polished plate glass [11] ... square feet	7,493,000	7,651,000	+2
Foundry activity:			
Foundry and malleable pig-iron production ... gross tons	1,521,945	2,154,349	+42
Malleable castings [12] ... short tons	268,638	369,458	+38
Freight-car loadings, all commodities: Total, monthly average [13] ... cars	2,415,000	2,566,000	+6

1 Many of the data available in this table are published currently in "Survey of Current Business"; comparable data for 1928 are given in Minerals Yearbook, 1934, p. 839.
2 Figures for 1934 are subject to revision.
3 Interstate Commerce Commission.
4 Chief statistician, Board of Engineers for Rivers and Harbors.
5 Detailed statistics of construction are contained in the cement chapter in this volume.
6 Portland Cement Association.
7 F. W. Dodge Corporation.
8 Interstate Commerce Commission and Bureau of Railway Economics.
9 Glass Container Association.
10 Illuminating Glassware Guild.
11 Plate Glass Manufacturers of America.
12 U. S. Bureau of the Census.
13 American Railway Association.

Highway construction.—Concrete-highway construction was maintained in 1934 at about the same low level as in 1933. According to statistics of the Portland Cement Association total concrete-pavement contract awards were only 45,108,000 square yards, virtually no change from 1933 but a drop of 70 percent from the 1928 peak.

General trends in construction of bituminous roads are shown by statistics of asphalt shipments and road-oil sales. Shipments of paving asphalt increased from 798,607 short tons in 1933 to 924,135 short tons in 1934, an advance of 16 percent. Shipments of cut-back asphalts, commonly used for mixed-in-place bituminous surfaces, increased 23 percent (from 508,553 short tons in 1933 to 624,183 short tons in 1934). Road-oil sales also picked up in 1934, increasing 23 percent (from 6,238,898 barrels in 1933 to 7,702,753 barrels in 1934).

These data tend to confirm partial returns from sand and gravel producers indicating that production of paving sand by commercial operations amounted to about 11,500,000 short tons in 1934, an increase of 5 percent over the 10,903,447 short tons in 1933. Paving-gravel production apparently increased about 10 percent—from 17,719,859 short tons in 1933 to about 19,500,000 short tons in 1934.

Nearly all the sand and gravel reported by noncommercial producers also is used for paving, and this material should be included in total figures for aggregates consumed in highway and road construction. Preliminary returns indicated that the quantity of sand and gravel produced by noncommercial operations in 1934 may have declined about 10 percent compared with 1933.

Building construction.—Total construction contracts awarded in 37 States east of the Rocky Mountains during 1934 were valued at $1,543,842,000 according to statistics of the F. W. Dodge Corporation. Although this total represents an advance of 23 percent compared with 1933 it is still 77 percent below the 1928 peak. Supplementary records of construction activity also show moderate advances in 1934. The value of building permits issued in 819 cities throughout the United States increased 6 percent over 1933; engineering-construction contract awards advanced 27 percent.

Returns from approximately half the commercial sand and gravel producers substantiate the indicators of demand for building sand and gravel. Production of building sand in 1934 was about 16,400,000 short tons, an increase of 26 percent over the 13,024,174 short tons in 1933. The output of building gravel increased about 22 percent—from 11,934,080 short tons in 1933 to 14,500,000 short tons in 1934.

Railroad ballast.—Demand for railroad ballast declined sharply as a result of railroad economies during the depression, but in 1934 there was a moderate upturn in expenditures for ballast. Estimates of the Bureau of Railway Economics indicate that total ballast expenditures by class I roads in 1934 were about $8,855,000, an increase of 13 percent over the $7,814,385 in 1933. Although expenditures include all kinds of material used as ballast, as well as transportation and unloading costs, about 60 percent of the reported expenditures represents actual cost of the material.

Preliminary returns from producers also show an increase in ballast production, and available data indicate an output of ballast gravel in 1934 amounting to 5,500,000 short tons, an advance of 12 percent over

1933. Railroad-ballast sand may have dropped about 10 percent in 1934 compared with 1933.

Other outlets.—Production of glass sand in 1934 was about 1,920,000 short tons, 8 percent higher than in 1933, according to returns from companies accounting for nearly 90 percent of the total output in 1933. Comparable data on production of glass containers are not available but shipments in 1934 increased 6 percent compared with 1933. The output of plate glass, the other large outlet for glass sand, barely surpassed the 1933 production. Illuminating-glassware production in 1934 advanced 9 percent over 1933.

Activity in the steel and foundry industries was reflected in an increase of 30 percent in the output of molding sand in 1934 compared with 1933, and of 41 percent in the output of fire or furnace sand.

The demand for grinding and polishing sand depends directly upon conditions in the dimension-stone and plate-glass industries, and preliminary returns indicate an increase in output of 1 percent in 1934 compared with 1933.

Freight-car loadings, which advanced 6 percent in 1934, may bear some relation to demand for engine sand, and reports of producers indicate that the output in 1934 was about 19 percent higher than in 1933.

Partial returns from producers show an apparent increase of 44 percent in the output of filter sand in 1934 and a drop of 31 percent in production of sands used for miscellaneous or unspecified purposes.

OPERATION UNDER THE CODE

A Code of Fair Competition for the Crushed Stone, Sand and Gravel, and Slag Industries[3] became effective November 20, 1933. At its annual meeting on January 28, 1935, the code authority, after reviewing the operation of the code, adopted a resolution expressing its judgment that the code "has been directly responsible for the improvement of conditions within our industries achieved during 1934" and urged that the basic principles underlying the National Industrial Recovery Act should not be disturbed or modified in the enactment of legislation for continuance of the act. Since the code authority was representative of the crushed stone, sand and gravel, and slag industries throughout the United States it is reasonable to assume that the resolution—a copy of which was forwarded to the National Industrial Recovery Board—reflected the majority opinion of the members of the industries.

It was recognized by the code authority that certain phases of the code, with particular reference to the definitions thereof, should be reviewed for the purpose of simplification and application of experience gained during code administration. Accordingly, conferences were instituted with the N. R. A., and the definitions contained in the code were subjected to a public hearing, with particular reference to the so-called "contractor-producer problem." The revised definitions had not been approved by May 15, 1935, but it was hoped that out of the discussion would grow a procedure for establishing committees in each State charged with responsibility of recommending to the N. R. A. a basis of division as to code jurisdiction between materials-supply contracts and bona fide construction contracts.

[3] Abstracted in Minerals Yearbook, 1934, pp. 844–8.

Materials produced by a contractor for his own consumption would probably be withdrawn from the jurisdiction of the Code of Fair Competition for the Crushed Stone, Sand and Gravel, and Slag Industries, but materials produced in the execution of materials-supply contracts would remain under the jurisdiction of the code for the aggregates industries.

Hours and wage rates.—Data collected by the code authority covering operations of a representative cross-section of the industries in May and June 1934 showed an increase of 34 percent in employment from 1933 to 1934. Total wages paid increased 43 percent, and there was also an advance in the average hourly wage. During the first half of 1934 the hours worked per week averaged close to the maximum of 40 hours permitted by the code.

Although the code authority submitted a proposal to the administration for the establishment of minimum wages and maximum hours for employees working as crews on floating equipment engaged solely in the dredging and transportation of the products of the industries on navigable waters, final decision in this regard was not reached during 1934.

Cost accounting.—Section 2 of article VII of the code provided that the code authority submit to the administration for its approval a standard uniform accounting and costing system for each industry governed by the provisions of the code. It was provided further that upon approval of this system, each member should adhere to the standard uniform system for the industry or industries in which he was engaged to the extent of incorporating in his calculations of cost all the elements prescribed by the system. The code authority discharged its responsibilities in this regard, but the N. R. A. did not extend its approval of the systems, failure to do so being in deference to a general policy that was applied not only to the crushed stone, sand and gravel, and slag industries but to 60 other industries as well, each of which had accounting and costing provisions similar to those contained in the aggregates code.

Permissive areas.—Section 5 of article VII of the code provided for the appointment of committees whose function it would be to review existing productive capacity in each State; if it was found that such capacity exceeded normal or potential requirements, the committees were authorized to recommend the establishment of permissive areas for the approval of the administration. When such permissive areas were approved there could be no increase in productive capacity unless the undertaking had the approval of the interested State committee and the code authority. California was the first State in which permissive areas were approved by the administration, and subsequently four additional States gained the same privilege. It is understood that permissive areas in all except one State had been allowed to expire by the administration, with the result that, except for this one State, section 5 of article VII of the code was not operative.

Open prices.—District committees were authorized, subject to the approval of the interested regional committee and the code authority, to adopt the open-price policy under the provisions of section 2 of article VII of the code. Approximately 90 percent of the districts availed themselves of this opportunity. The code authority held that the open-price policy had been effective in rehabilitation of the industries and that its continued operation was not contrary to public policy. The chairman of the code authority, during the extensive hearing by the National Industrial Recovery Board on the subject of price provisions of all codes, emphasized that the open-price policy, as provided for in the aggregates code, was not subject to the criticism of price fixing and that its continued operation was essential to the industries in assuming the burdens of increased labor costs growing out of the code.

Sections 3 and 4 of article VII of the code permitted district committees to recommend uniform marketing rules for approval of the administration. Such uniform marketing rules were established in 14 districts, and their operation, according to the code authority, effectively supplemented the open-price policy.

GYPSUM

By Paul M. Tyler and R. W. Metcalf

SUMMARY OUTLINE

A 23-percent upturn in general construction activity was reflected in a 15-percent increase in gypsum production which was handicapped heavily by the continued failure of residential building to make much recovery from the extreme discouragement that followed 3 years of virtual stagnation. Virtually all this improvement in gypsum sales was absorbed by the domestic industry, as the increase in imports was almost imperceptible.

Crude gypsum produced in the United States in 1934 totaled 1,536,170 short tons compared with 1,335,192 tons in 1933 (the worst year since 1905) and 5,678,302 tons in 1925, the record year. Imports during 1934, mostly from Canada, were 360,186 tons compared with 359,490 tons in 1933 and a maximum of 1,036,385 tons in 1929. Sales of gypsum products manufactured in American plants from gypsum of both domestic and foreign origin totaled 1,140,590 tons valued at $16,184,459, of which 1,074,017 tons valued at $15,510,835, or well over 90 percent, were sold or used for building purposes. Moderate price improvement accompanied the expansion in sales of gypsum products; but prices of crude gypsum sold to cement mills dropped slightly, and, due to a relative increase in sales of lower priced material the average price of all crude shipments declined.

Imports of gypsum products, never large, declined further, and exports picked up slightly.

Salient statistics for the gypsum industry for recent years are summarized in the following table:

Salient statistics on gypsum and gypsum products in the United States, 1925–34

	1925–29 (average)	1930	1931	1932	1933	1934
Crude gypsum:						
Mined.....short tons..	5,355,803	3,471,393	2,559,017	1,416,274	1,335,192	1,536,170
Imported..........do....	870,465	902,358	713,880	374,072	359,490	361,186
Apparent supply..........do....	6,226,268	4,373,751	3,272,897	1,790,346	1,694,682	1,897,356
Sales by domestic plants:[1]						
Raw gypsum:						
Short tons..........	1,086,762	1,083,106	851,443	516,136	491,273	578,947
Value..............	$2,700,289	$2,277,404	$1,882,557	$1,216,388	$1,089,100	$1,266,945
Gypsum products:						
For building purposes:						
Short tons......	[2] 4,342,662	[2] 2,641,873	[3 4] 2,077,214	[3 4] 1,149,872	[3] 1,011,506	[3] 1,074,017
Value..........	[2] $43,598,431	[2] $31,740,539	[3 4] $26,359,518	[3 4] $16,122,200	[3] $14,085,071	[3] $15,510,835
For manufacturing uses:						
Short tons......	[2] 124,464	[2] 197,665	[4] 55,172	[4] 43,889	48,965	66,573
Value..........	[2] $1,017,146	[2] $1,636,528	[4] $478,589	[4] $454,718	$470,041	$673,624
Total gypsum products sold:						
Short tons......	4,467,126	2,839,538	2,132,386	1,193,761	1,060,471	1,140,590
Value..........	$44,615,577	$33,377,067	$26,838,107	$16,576,918	$14,555,112	$16,184,459
Grand total sales:						
Short tons..........	5,553,888	3,922,644	2,983,829	1,709,897	1,551,744	1,719,537
Value..............	$47,315,866	$35,654,471	$28,720,664	$17,793,306	$15,644,212	$17,451,404
Gypsum products imported:[5]						
Short tons..............	8,231	7,708	7,364	3,302	3,108	1,646
Value..................	$118,547	$113,134	$76,373	$29,365	$33,413	$26,436
Exports:						
Plaster board, etc.:						
Square feet..........	[6] 14,389,545	16,677,518	6,386,649	1,981,685	1,646,733	1,895,700
Value..............	[6] $363,263	$431,072	$157,897	$46,175	$36,057	$43,041
All other:[7]						
Short tons..........	[6] 22,009	23,611	11,275	4,919	5,333	4,853
Value..............	[6] $466,680	$420,728	$234,540	$91,025	$83,155	$90,451

[1] Gypsum and gypsum products produced from rock of both domestic and foreign origin.
[2] Some gypsum products (from imported rock) for manufacturing uses included with those for building purposes.
[3] Includes calcined gypsum sold to other manufacturers and for miscellaneous uses.
[4] Revised figures.
[5] Includes ground and calcined gypsum and Keene's cement, but not "manufactures of which plaster of paris is the component material of chief value n. s. p. f." (principally statues, art goods, and novelties).
[6] Average for the 3 years, 1927–29, only.
[7] Includes raw and calcined gypsum and gypsum products.

DOMESTIC PRODUCTION AND SALES

The 1934 production of 1,536,170 short tons of crude gypsum was supplied by 36 companies operating 57 mines.

The four leading gypsum-mining States accounted for nearly two-thirds of the total output. New York produced 391,408 tons (363,745 tons in 1933); Michigan 281,033 tons (211,392 tons in 1933); Iowa 180,271 tons (172,555 tons in 1933); and Texas 138,326 tons (112,106 tons in 1933). Increases were reported in every State except Arizona and California, where the decrease was small.

As shown in the accompanying tables the production of raw or uncalcined gypsum of domestic origin sold or used by producers during 1934 totaled 512,317 short tons valued at $970,828 compared with 420,935 tons valued at $806,325 in 1933, increases of 22 percent and 20 percent in quantity and value, respectively. Sales of domestic calcined gypsum rose to 902,539 tons valued at $12,791,149 as against 821,738 tons valued at $11,121,153 in 1933, representing an increase of scarcely 10 percent in tonnage but an advance of 15 percent in value. The total realization from sales of both raw and calcined gypsum in 1934 aggregated $13,761,977, or 15 percent more than the 1933 total of $11,927,478. The calculated average sales realization per ton of gypsum mined, however, was practically the same in both years or slightly under $9 a ton, better prices for calcined being offset by relatively larger sales of uncalcined gypsum at a lower average price. Before the World War the average sales realization per ton mined was under $3, but subsequently it has risen more or less steadily, partly due to a general rise in prices but more particularly to the increase in the relative tonnage of plaster and board products sold compared with the tonnage of gypsum sold without calcining.

As recently as 10 years ago there was a fairly substantial sale of calcined gypsum to independent factories manufacturing wall board and other more highly finished products, but even this type of business has been absorbed to a considerable extent by the larger gypsum-producing companies, some of which have even extended their wnership into the control of mining and processing facilities for furnishing accessories and raw materials other than gypsum, such as lime, expanded metal, and various fillers.

Gypsum mined and uncalcined and calcined gypsum sold or used by producers in the United States, 1925–34

Year	Number of active establishments [1]	Total quantity mined (short tons)	Sold or used by producers: Without calcining — Short tons	Without calcining — Value	Calcined — Short tons	Calcined — Value	Total value
1925–29 (average)	64	5,355,803	1,001,196	$2,344,118	3,805,501	$37,616,291	$39,960,409
1930	62	3,471,393	989,591	1,886,254	2,191,376	25,165,230	27,051,484
1931	60	2,559,017	773,185	1,565,367	1,593,753	19,235,990	20,801,357
1932	57	1,416,274	444,816	929,567	890,495	11,976,719	12,906,286
1933	61	1,335,192	420,935	806,325	821,738	11,121,153	11,927,478
1934	64	1,536,170	512,317	970,828	902,539	12,791,149	13,761,977

[1] Each mine, plant, or combination mine and plant is considered as 1 establishment.

Gypsum mined and uncalcined and calcined gypsum sold or used by producers in the United States in 1934, by States

State	Number of active establishments [1]	Total quantity mined (short tons)	Sold or used by producers: Without calcining — Short tons	Without calcining — Value	Calcined — Short tons	Calcined — Value	Total value
Arizona	1	765			1,463	$15,413	$15,413
California	6	55,620	25,458	$92,978	(2)	(2)	(2)
Iowa	8	180,271	63,510	97,626	115,282	1,572,730	1,670,356
Kansas	2	68,655	20,141	21,048	34,782	362,862	383,910
Michigan	8	281,033	90,481	180,624	163,282	2,288,598	2,469,222
Nevada	3	82,348	47,317	111,447	(2)	(2)	(2)
New York	11	391,408	131,925	237,647	237,438	3,684,882	3,922,529
Oklahoma	4	105,620	38,440	47,460	(2)	(2)	(2)
Texas	5	138,326	25,887	36,586	98,471	1,366,868	1,403,454
Other States [3]	16	232,124	69,158	145,412	[4] 251,821	[4] 3,499,796	[4] 3,897,093
	64	1,536,170	512,317	970,828	902,539	12,791,149	13,761,977

[1] Each mine, plant, or combination mine and plant is considered as 1 establishment.
[2] Included under "Other States."
[3] Colorado, Montana, Ohio, South Dakota, Utah, Virginia, and Wyoming.
[4] This figure includes also sales from California, Nevada, and Oklahoma.

Calcined gypsum used.—Beginning in 1931 the Bureau of Mines has requested manufacturers of gypsum products from domestic rock to report the tonnage of calcined gypsum used in specified products. Unfortunately, these data are not quite so complete as the sales and production statistics, and there is some difficulty in reconciling them with the other figures reported. Due to storage problems as well as to the principle of avoiding unnecessary tie-up of working capital in material in process there is no inducement to build up large stocks of stucco or semifinished plaster products, and inventory adjustments accordingly are small enough so that the figures of consumption of calcined gypsum are fairly close to the actual yield of stucco from the kettles and kilns. However, no figures showing the quantities of raw gypsum charged to the calcining equipment are available, and the figure obtained by deducting sales of raw gypsum from total quantities mined is only a rough approximation of quantity charged because of losses and adjustments between mine and factory figures as well as fluctuations in stocks. Under these circumstances no real comparison can be made between the tonnage of calcined gypsum produced and the raw gypsum required therefor.

Comparison of returns from individual manufacturers indicates considerable difference in the quantities of calcined gypsum used per ton of product, and there is not much uniformity in the aggregate returns in different years. Eventually, however, average figures over a period of years may shed some light upon typical practice, and figures may be developed to show whether the trend is toward the use of more or less admixed materials other than gypsum. With respect to plasters, however, local conditions are a disturbing factor; for example, heavily sanded plasters are likely to be more in demand than neat plaster in localities near the gypsum plants or where sand is not readily obtained.

Domestic calcined gypsum used by producers in manufacture of gypsum products in the United States in 1934, by States and uses, in short tons

	Board	Tile	Plaster [1]	Other purposes	Total
Calcined gypsum used:					
Iowa	15,269	7,688	72,928		95,885
Kansas			20,266		20,266
Michigan	21,592	664	69,443	2	91,701
New York	66,753	14,051	123,302	3,356	207,462
Texas	17,797	1,234	75,601		94,632
Other States [2]	39,483	3,657	200,317	1,552	245,009
	160,894	27,294	561,857	4,910	754,955
Products sold: [3]					
Gross weight [4]	191,449	29,845	611,953	5,001	838,248
Percent of total sales of domestic calcined gypsum products	95.0	95.3	92.8	50.1	92.9

[1] Includes wall plaster and calcined gypsum for manufacturing uses.
[2] Arizona, California, Indiana (crude gypsum from Michinga), Montana, Nevada, Ohio, Oklahoma, Utah, Virginia, Wisconsin, and Wyoming.
[3] As reported by producers of domestic calcined gypsum showing consumption by uses.
[4] Includes hair, fiber, reinforcing, filler, or other materials used with calcined gypsum in manufacture of gypsum products.

Active kettles and kilns.—The number of calcining plants treating domestic rock increased to 42 in 1934, one more than in 1933. The rated capacity of the equipment operated declined slightly, but inasmuch as it still was more than 5 times larger than was needed this was not particularly significant. The demand for gypsum products is distinctly seasonal, and the industry has not been able to equalize manufacturing activities over the 12 months. Inasmuch as the products are semiperishable errors in forecasting sales might prove serious, and many steps in the manufacturing processes are more or less intermittent in character so that continuous operation of equipment is not so essential as in some chemical or metallurgical industries. For these reasons, among others, gypsum plants generally have rather limited storage facilities. Average production for the year is typically 25 percent below the peak production in August. According to the Gypsum Association, the practical working year of the industry is 230 days, and mineral economists affiliated with the Brookings Institution[1] consider that 1925 represents virtually the maximum attainable use of equipment. In 1925 the estimated capacity (in terms of raw rock charged) was 23,000 tons daily compared with an output of 4,096,357 tons of calcined gypsum products. As noted elsewhere, the production of gypsum from domestic sources subsequently declined, first because of increased importations of Canadian crude gypsum and later because of diminishing demand; but plant capacity continued to grow, reaching a peak of 30,371 tons of raw rock daily in 1930. This figure, which takes no account of capacity of plants that were actually idle throughout the year, indicated production at a rate of 40 percent of capacity. Similar estimates show a decline to 17-percent operation in 1933, rising to 19.6 percent in 1934.[2] The increase in rated capacity of calcining equipment to the peak in 1930 was attributable to increases in the number of rotary and vertical kilns; the rated capacity of kettle equipment has remained about the same year after year.

Calcining kettles[1] and kilns reported by gypsum producers in the United States in 1934, by States

State	Number of calcining plants	Kettles[1]		Rotary kilns		Total daily capacity (short tons)
		Number	Daily capacity (short tons)	Number	Daily capacity (short tons)	
Arizona	1	2	150			150
Iowa	5	25	4,434	1	(2)	[3] 4,434
Kansas	2	4	270	3	315	585
Michigan	5	22	2,465			2,465
New York	6	21	3,045	5	2,460	5,505
Texas	4	29	2,620			2,620
Other States[4]	19	55	6,452	3	2,240	8,692
Total, 1934	42	158	19,436	12	[5] 5,015	[3] 24,451
Total, 1933	41	156	19,671	[6] 20	[6] 5,835	[5] 25,506

[1] Data for kettles in 1934 include 4 "beehives", with rated capacity of 36 tons.
[2] Capacity not reported.
[3] Includes for Iowa capacity of kettles only.
[4] California, Colorado, Indiana (crude gypsum from Michigan), Montana, Nevada, Ohio, Oklahoma, South Dakota, Utah, Virginia, and Wyoming.
[5] Exclusive of Iowa.
[6] Includes 5 vertical kilns in Utah and Virginia—reported capacity 20 tons.

[1] Nourse, E. G., Tryon, F. G., and others, America's Capacity to Produce: Washington, 1934, pp. 135–559.
[2] The actual condition may have been less favorable even than these figures indicate for the Brookings Institution method for calculating raw rock treated yielded relatively high results.

PRICES

Expansion in the gross value of the output of gypsum and gypsum products as reported by the Bureau of Mines has been largely the result of increasing integration of the industry. Crude gypsum never has been a high-priced product, and mining companies soon found that their best prospects for growth were in the direction of processing their product and catering to the wants of the ultimate consumer rather than in trying merely to expand their sales of crude gypsum. Whereas in 1910 the average value of sales of gypsum and gypsum products was only $2.74 per ton mined the figure in 1920 reached $7.84 and in 1925 it was $8.38. These figures afford a rough index of the increased sales realization by producers per ton of crude gypsum mined but do not measure the price trends with respect to either crude gypsum or its products.

Probably the best measure of price fluctuations of crude gypsum is furnished by the calculated average sales values for portland cement retarder. Quotations of crude gypsum have been given from time to time in various trade publications but seldom reflect actual prices or even the major fluctuations of prices, either in specified States or in the country as a whole. Before 1914 the unit values of domestic crude gypsum sales fluctuated considerably but eventually seemed to approach stability at about the 1910–14 average of $1.45 a short ton. In 1920 the price jumped to a peak of $3.58, but subsequently it has shown signs of making a bottom somewhere around $1.80 a ton. Average prices of land plaster are subject to much more fluctuation because of more erratic geographical distribution as well as differences in degree of preparation; the 1934 average of domestic sales was $4.96 a ton compared with $5.57 in 1933 and a 1910–14 average of less than $2.00.

Average values per short ton of gypsum and gypsum products made from domestic crude gypsum and sold or used by producers in the United States, in selected years from 1910 to 1934

Use	1910	1920	1925	1929	1931	1933	1934
Sold without calcining:							
To portland cement mills	$1.56	$3.58	$2.66	$1.88	$1.91	$1.78	$1.75
For agriculture	2.05	5.19	5.92	4.23	4.89	5.57	4.96
For other purposes	1.10	3.32	7.19	2.88	1.99	2.25	1.98
Average raw sales	1.59	3.83	2.78	1.97	2.02	1.92	1.89
Calcined products:							
Base-coat plasters	(1)	(1)	(1)	(1)	7.99	8.79	9.57
Building plasters, total	[2] 3.78	9.91	7.48	5.15	7.99	9.10	9.70
Keene's cement	(1)	14.90	13.75	14.67	14.36	14.35	15.34
Plaster board and lath	(1)	(1)	24.99	15.17	18.09	19.26	18.79
Wall board	(1)	(1)	32.66	20.10	30.70	34.14	35.35
Average calcined sales [3]	3.43	11.53	10.93	8.69	12.07	13.53	14.17
Sales realization per ton crude gypsum mined [4]	2.74	7.84	8.38	6.24	8.13	8.93	8.96

[1] Figures not available.
[2] Includes Keene's cement and some dental plaster and other products.
[3] The increase in this item before 1925 was due in large measure to increasing integration, as some wall board and other high-priced products were made by plants owned by gypsum producers instead of outside plants purchasing their raw or calcined gypsum from the primary producers.
[4] Calculated by dividing total value of all sales by tons of crude gypsum mined.

Even more difficulty is found in obtaining an index of prices of calcined gypsum plaster or manufactured products like wall board. Changes in classification of Bureau of Mines statistics prevent comparison of values of different types before 1931 with later figures, and comparisons of average values for all kinds of "building plasters" may be influenced by changes in the relative quantities of higher-priced plaster produced. A large increase in the proportion of plaster board and wall board included in sales by primary producers contributes to the much higher average value of calcined gypsum sales after the war compared with 1910 and tends to raise the average in later years.

Notwithstanding the difficulties noted in the foregoing paragraph the accompanying table confirms the general statement that the prices of gypsum products increased substantially more than the prices of crude gypsum from 1914 to 1920 and that the upward movement of prices of gypsum and most of its derivatives reached a climax about 1925 and by 1927 were being undermined rapidly by competition between leading domestic producers. Later, while prices of many other products were tumbling rapidly, gypsum plaster and various other gypsum manufactures were rising countercurrent to the general recession.

At the beginning of 1935 downward revisions in prices of specific gypsum products delivered on the job in New York City were reported by the Dow service, as follows:

	Dec. 21, 1934	Jan. 18, 1935
Plaster:		
Neat wall (in paper) short ton	$15.625	$14.50
Mortar (sanded) Browning-scratch 3-1 do	11.875	12.00
Bond plaster do	16.875	16.00
Finishing and molding plaster (100-lb. bags) do	21.50	20.00
Plaster boards:		
¼-inch each	.1505	.14
⅜-inch do	.1612	.16
½-inch do	.1844	.1844
Plaster lath 1,000 feet	50.00	50.00

DISTRIBUTION OF SALES

In 1934, as in former years, sales of raw gypsum consisted mainly of crude rock for portland-cement retarder, which amounted to 460,846 tons from foreign and domestic sources compared with a maximum of 1,075,652 tons in 1929. Sales of agricultural gypsum, or land plaster, rose to over 100,000 tons annually from domestic sources alone in the early 1920's, but this increase was largely temporary, reflecting the need for renewing soils following the intensive farming during the World War. After 1922 annual sales of land plaster dropped sharply; in 1934 they amounted to a total of 60,403 tons, more than during any year since 1929. Whereas sales to cement makers are of crude gypsum or gypsum that has simply been crushed to convenient size for handling (about one-half inch), gypsum for agricultural uses has to be ground or pulverized to pass at least 20-mesh and ordinarily much finer. The cost of this extra preparatory treatment naturally adds to the price, and in 1934 the average value of domestic land-plaster sales was approximately $5 per ton compared with only $1.50 to $2 for material destined for portland-cement manufacture. Variable amounts of gypsum are sold raw for other purposes, such as paint manufacture and terra alba, filler, insulating material, rock dust, and wall plaster; generally this material is sold crude, but occasionally some of it, too, may be pulverized or otherwise manufactured or prepared.

Inasmuch as cement production did not decrease as sharply as the demand for calcined gypsum products about one-third of the gypsum consumption in recent years has been sold raw, whereas in 1926 the proportion was only one-sixth, about the same as in 1910–14. Previous to about 1890 the amount of crude gypsum sold as land plaster roughly equaled and in the earlier years exceeded the quantity made into plaster.

Calcined gypsum is produced in the United States from both domestic and foreign crude gypsum. About 1.2 tons of raw gypsum are required to produce a ton of calcined gypsum, but the weights of gypsum products as reported in the following tables include the weight of added material, such as filler, fiber, paper, and reinforcing. Because of these additions the gross weight of gypsum products, as reported, is not directly comparable with the data for crude gypsum sent to calcining kettles, or even to the output of calcined gypsum (figures for which are available for recent years). Nevertheless, due to the preponderance of neat plaster sold and the relatively small amounts of materials added to many other products the aggregate tonnage figures do reflect rather closely the ups and downs of kettle output and the state of the manufacturing industry generally. They even afford a basis of comparing the consumption of calcined gypsum with that of crude, subject to a probable error of not more than 5 or 10 percent.

Crude gypsum and gypsum products made from domestic crude gypsum sold or used by producers in the United States, 1933–34, by uses

Use	1933		1934	
	Short tons	Value	Short tons	Value
Without calcining:				
To portland cement mills	376,886	$669,029	441,014	$773,977
For agriculture	11,479	63,892	18,595	92,287
For other purposes [1]	32,570	73,404	52,708	104,564
Total without calcining	420,935	806,325	512,317	970,828
Calcined:				
For building purposes:				
Base-coat plasters	438,126	3,851,940	469,188	4,492,271
Sanded plasters	34,529	241,624	47,877	330,652
Finished plasters	34,141	422,800	39,052	483,758
Molding plasters	22,957	304,836	23,197	310,444
Keene's cement	13,529	194,075	13,613	208,794
Plaster board and lath	[2] 59,645	1,148,704	[2] 73,804	1,386,480
Wall board	[3] 119,748	4,088,393	[3] 127,665	4,512,721
Partition tile	[4] 27,587	176,718	[4] 26,265	198,113
Insulating materials	2,557	34,469	1,616	19,449
Other building purposes [5]	7,080	115,435	7,842	125,709
Total for building purposes	759,899	10,578,994	830,119	12,068,391
For manufacturing uses:				
To plate-glass works	18,467	127,205	15,831	92,883
To terra cotta works	1,875	14,599	1,243	10,218
To pottery works	9,313	81,825	26,221	264,013
For other manufacturing uses [6]	16,132	204,572	19,151	258,786
Total for manufacturing uses	45,787	428,201	62,446	625,900
For other purposes [7]	16,052	113,958	9,974	96,858
Total calcined	821,738	11,121,153	902,539	12,791,149
Grand total value		11,927,478		13,761,977

[1] Includes gypsum sold for filler, insulating materials, paint manufacturing, and rock dust.
[2] 1933: 77,858,195 square feet; 1934: 96,194,226 square feet.
[3] 1933: 157,895,617 square feet; 1934: 169,934,547 square feet.
[4] 1933: 4,687,736 square feet; 1934: 4,421,657 square feet.
[5] Includes joint filler, patching plaster, "roofing tile", "other tile", and pyrofill.
[6] Includes dental plaster, hydrocal, coecal, casting and molding plaster, paper and paint filler, and stucco.
[7] Includes calcined gypsum sold to other manufacturers and for miscellaneous uses.

Base-coat plaster accounts for the bulk of the tonnage of calcined gypsum, and other plasters in the aggregate also represent a substantial tonnage. Whereas the average value of domestic base-coat plasters in 1934 was $9.57 a ton, sanded plasters were worth only $6.91 a ton. Finished plasters were worth $12.39 and consequently contributed notably to the total value of consumption, although the quantity was relatively small. Wall board is a very important item, exceeding base-coat plasters in value of production though representing about one-fourth as much tonnage. Plaster board and lath constitute the next most important item, especially as regards value, inasmuch as manufactured partition tile, once of considerable consequence, has dwindled greatly in recent years because of the small volume of construction for which gypsum tile is particularly adapted. The production of Keene's cement rose to a maximum of 54,020 short tons valued at $848,504 in 1928 but later suffered more even than other gypsum products from the effects of the depression.

The distribution of sales of crude gypsum and gypsum products is shown in the accompanying tables, one of production from domestic crude gypsum and the other production from imported crude. Some combinations of these figures are given in the summary table of salient statistics on an earlier page.

Imported crude gypsum and gypsum products made from imported crude gypsum, sold or used in the United States, 1931–34, by uses, as reported to the Bureau of Mines by the importers

Use	1931		1932	
	Short tons	Value	Short tons	Value
Without calcining:				
To portland cement mills	48,326	$161,563	35,545	$86,249
For agriculture	17,353	93,648	31,760	166,944
For other purposes	12,579	61,979	4,015	33,628
Total without calcining	78,258	317,190	71,320	286,821
Calcined:				
For building purposes:				
Base-coat plasters	273,071	2,614,718	164,036	1,554,590
Sanded plasters	37,858	253,645	18,519	136,991
Finished plasters	69,996	1,027,489	34,169	487,117
Molding plasters	23,595	418,465	11,732	178,733
For other building purposes [1]	[2] 128,221	[2] 3,223,888	[2] 71,726	[2] 2,209,250
Total for building purposes	[2] 532,741	[2] 7,538,205	[2] 300,182	[2] 4,566,681
For manufacturing uses [3]	[2] 5,892	[2] 63,912	[2] 3,084	[2] 33,518
Total calcined	538,633	7,602,117	303,266	4,600,199
Grand total value		7,919,307		4,887,020

[1] Includes calcined gypsum used for Keene's cement, plaster board, lath, wall board, partition tile, roofing tile, insulating materials, and other building purposes, and calcined gypsum sold to other gypsum manufacturers and for miscellaneous uses.
[2] Revised figures.
[3] Includes gypsum sold to potteries and for other manufacturing uses.

Imported crude gypsum and gypsum products made from imported crude gypsum, sold or used in the United States, 1931–34, by uses, as reported to the Bureau of Mines by the importers—Continued

Use	1933		1934	
	Short tons	Value	Short tons	Value
Without calcining:				
To portland cement mills	24,495	$46,490	19,832	$42,401
For agriculture	40,847	186,072	41,808	210,594
For other purposes	4,996	50,213	4,990	43,122
Total without calcining	70,338	282,775	66,630	296,117
Calcined:				
For building purposes:				
Base-coat plasters	116,726	1,059,583	111,110	1,055,052
Sanded plasters	11,955	89,163	11,004	87,084
Finished plasters	36,017	543,221	37,281	548,908
Molding plasters	6,324	89,001	6,025	85,145
For other building purposes [1]	[2] 64,533	[2] 1,611,151	68,504	1,569,397
Total for building purposes	[2] 235,555	[2] 3,392,119	233,924	3,345,586
For manufacturing uses [3]	[2] 3,178	[2] 41,840	4,127	47,724
Total calcined	238,733	3,433,959	238,051	3,393,310
Grand total value		3,716,734		3,689,427

[1] Includes calcined gypsum used for Keene's cement, plaster board, lath, wall board, partition tile, roofing tile, insulating materials, and other building purposes, and calcined gypsum sold to other gypsum manufacturers and for miscellaneous uses.
[2] Revised figures.
[3] Includes gypsum sold to potteries and for other manufacturing uses.

CONSUMPTION TRENDS

Gypsum has been mined in the United States since 1850. During the earlier decades it was consumed principally as land plaster, but as this use began to decline other outlets developed. Most of the present-day uses are related to the building industry, and beginning about 1890 gypsum products were rapidly displacing other building materials for various purposes. The rapid growth of portland cement manufacture later contributed to the continued expansion of the gypsum industry. The first real setback to domestic production occurred in 1926 and 1927, but during the next 2 years the falling off in use of domestic gypsum was nearly balanced by increasing imports. In 1929, however, the whole building industry began to collapse. Cement resisted the decline, and the sharp break in raw gypsum sales accordingly was postponed until 1930; in fact, the peak year was 1929. Even calcined gypsum products, after reaching a maximum in 1926, made a fairly good showing in 1929, although consumption had begun to diminish even before the slump in general building.

Raw gypsum.—Inasmuch as sales of raw gypsum consist so largely of cement retarder, they parallel closely the curve of portland-cement production. The correlation is almost perfect, except in a very few years when it would seem that expansion or contraction of gypsum shipments lagged behind changes in cement-mill activity. Data on stocks held by cement companies are not collected, but the prompt response of gypsum sales to changes in rate of cement production affords clear statistical evidence of a larger amount of hand-to-mouth buying during the depression period.

Calcined gypsum.—As might be expected the production of calcined gypsum follows the building curve even more closely than that of raw gypsum or portland cement, which was sustained to a greater

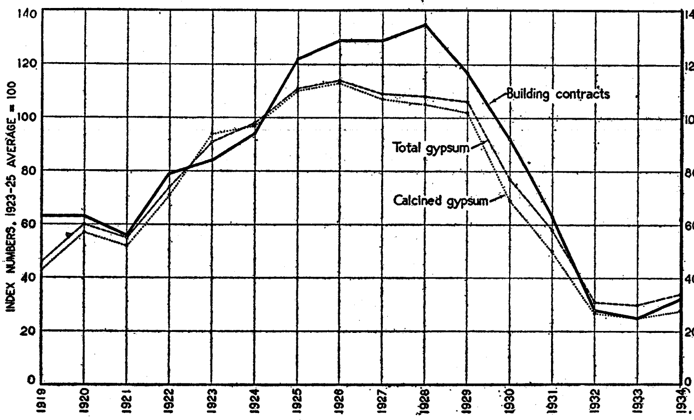

FIGURE 99.—Consumption of calcined gypsum and total consumption of gypsum compared with value of building contracts awarded, 1919–34.

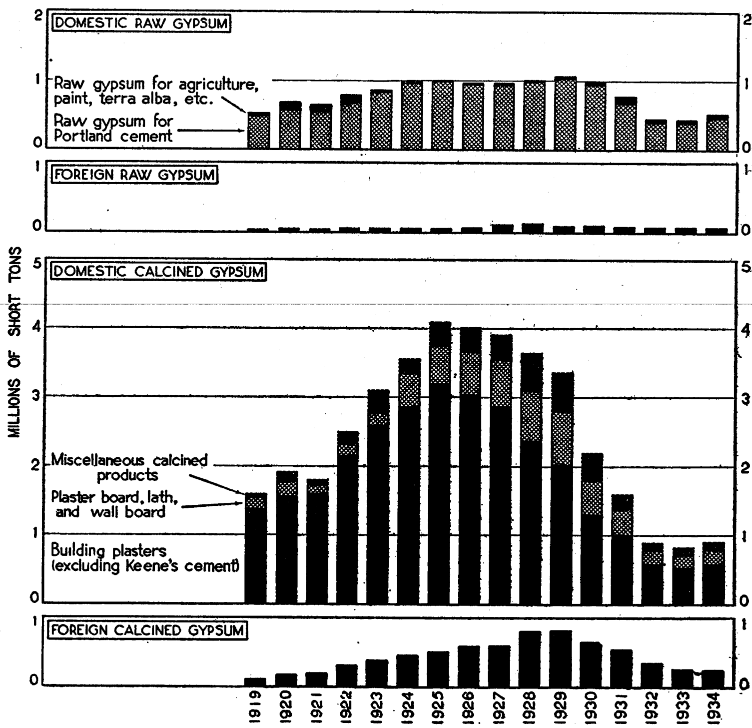

FIGURE 100.—Consumption in the United States of raw gypsum and gypsum products made from domestic and foreign crude gypsum, 1919–34, by uses. Data for 1919–26 partly estimated.

extent during the depression period by work-relief projects of various kinds. A study of the distribution of sales of gypsum products indicates a much larger proportion of wall board and similar more highly manufactured items. The increasing use of plaster board and wall board is a matter of common knowledge, but the statistics may exaggerate this trend, inasmuch as they reflect the production of primary producers who over a period of years have been going more and more into the field of finished products, while the production of independent concerns who purchased their calcined gypsum has declined correspondingly.

TECHNOLOGY AND USES

Trends in processing as well as in mining or quarrying gypsum in Canada have been reviewed by Cole.[3] A description of the new British plant which, as previously noted, follows up-to-date American practice, has also appeared recently.[4] Tube mills for regrinding are advocated by Turner,[5] who claims that tube-milling a very low-purity gypsum rejuvenates it to such an extent that plaster made therefrom can be sold where previously it had been a drug on the market.

Generally speaking, gypsum is far too abundant to justify exploitation of highly impure deposits, but mechanical separation might be economical under special circumstances. Canadian tests [6] demonstrate that fair grades of products may be obtained by jigging and tabling, although some gypsum is lost by solution. Flotation gives very poor results. Preliminary calcining followed by grinding in a Raymond pulverizer fitted with a throw-out attachment gives good separation from dolomite, and the dolomite product, itself containing a little gypsum, may have some value.

Two recent patents concerned with calcination are listed in the footnote reference [7] below.

Sodium bisulphate has been described [8] as the best catalyzer for the hydration of calcium sulphate. Dead-burned gypsum is ground finely and treated with 35 percent of its weight of water containing 0.1 to 6 percent $NaHSO_4$ dissolved therein. Cement so produced does not change in volume in ordinary air, in water, or in air heated to 120° C. for 1½ hours and has remarkable strength and resistance to dampness. A cement prepared by treating finely ground raw gypsum with bisulphate solution likewise is dense and resistant to dampness, keeps its volume, and can be mixed with sand.

Hansen (U. S. Patent 1975787, assigned to American Cyanamid Co.) has produced a waterproof gypsum product of desirable strength, setting time, and crystalline structure, incorporating 1 to 10 percent by weight of a solid, water-insoluble resinate. Another Hansen patent (U. S. Patent 1923370) covers a mixture of portland cement and calcined gypsum which, when properly gaged with water and mixed with inert filler, is claimed to produce a strong, light product which sets more quickly than portland cement alone and is more insoluble than gypsum cement alone.

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[3] Cole, L. H., Recent Trends in the Gypsum Industry in Canada: Paper read at February 1935 meeting of Am. Inst. Min. and Met. Eng., New York.

[4] Rock Products, British Gypsum Wall-Board Plant with Latest American Equipment: Vol. 37, no. 12, December 1934, pp. 30–32.

[5] Turner, A. M., Grinding Gypsum. With Particular Reference to Quality and Tube-Mill Regrinding: Rock Products, vol. 37, no. 6, June 1934, pp. 40–42.

[6] Carnochan, R. K., and Rogers, R. A., The Separation of Gypsum and Dolomite from Amaranth, Manitoba: Canadian Dept. Mines, Mines Branch, Rept. 736, 1934, pp. 225–228.

[7] U. S. Gypsum Co. (Birdseye, C. R., assignor), Calcination of Gypsum: U. S. Patent 1907717, May 9, 1933.

U. S. Gypsum Co. (Randel, W. S., and Dailey, M. C., assignors), Calcination of Gypsum: U. S. Patent 1931240, Oct. 17, 1933.

[8] Industrial Australian and Mining Standard, Anhydrous and Gypsum Cement: Vol. 89, no. 2277, June 1, 1934, p. 152.

Small quantities of gypsum have been employed for conditioning water at breweries, and the relatively new use of calcined gypsum for removing water from common distillery alcohol (about 94 percent), producing a practically absolute product (99.8 percent), continues to attract attention, both in Europe and the United States. The gypsum has to be specially prepared, and great quantities are required inasmuch as it can absorb only 6 percent of its own weight of water; but the material constitutes a remarkably effective drying agent, in addition to being cheap, noncorrosive, and easily regenerated.[9] It is offered in the United States at 60 cents per pound under the trade name Drierite (in 1- to 5-pound lots).[10]

FOREIGN TRADE [11]

Imports.—Imports of crude gypsum in 1934 were substantially the same quantity as in 1933, but the value declined slightly. The imports represent principally crude gypsum entered along the Atlantic seaboard from Canada and on the Pacific coast from Mexico.

Gypsum imported for consumption in the United States, 1925–34

Year	Crude		Ground		Calcined		Manufactured plaster of paris (value)	Keene's cement		Total value
	Short tons	Value	Short tons	Value	Short tons	Value		Short tons	Value	
1925–29 (average)	870,465	$1,152,279	2,899	$33,281	4,790	$71,616	$80,193	542	$13,650	$1,351,019
1929	1,036,385	1,060,874	3,224	29,500	1,755	40,203	71,479	430	11,327	1,213,383
1930	902,358	916,663	4,296	35,120	2,266	40,839	61,322	1,146	37,175	1,091,119
1931	713,880	713,313	4,806	40,809	2,430	32,552	36,825	128	3,012	826,511
1932	374,072	346,766	2,076	14,762	1,174	13,561	17,948	52	1,042	394,079
1933	359,490	373,919	1,907	18,032	1,177	14,781	13,305	24	600	420,637
1934	360,186	371,082	1,085	14,880	534	10,890	16,859	27	666	414,377

Crude gypsum imported into the United States, 1932–34, by countries [1]

Country	1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada	358,589	$332,908	338,189	$354,473	329,835	$341,283
Germany			17	75		
Italy	6	39				
Mexico	15,477	13,819	21,277	19,131	31,351	29,799
United Kingdom			7	240		
	374,072	346,766	359,490	373,919	361,186	371,082

[1] Data on total imports by countries during 1934 may not be strictly comparable with figures published in previous reports of this series due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in the system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

[9] Canadian Chemistry and Metallurgy, New Process of Alcohol Dehydration Based on Gypsum (a paper by Mr. Pusl before the Association of Sugar Technologists in Cuba): Vol. 18, no. 4, April 1934, p. 82.
[10] Rock Products, vol. 37, no. 5, May 1934, p. 56.
[11] Figures on imports and exports (unless otherwise indicated) compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

The foregoing figures somewhat exceed the quantities reported to the Bureau of Mines by 14 firms who imported 345,094 short tons in 1934 compared with 340,337 tons by 13 firms in 1933. As the following table indicates, this material was used mainly for making calcined gypsum (chiefly base-coat and finished plasters, although moderately large quantities are ground for land plaster (especially in Virginia) and, in some years, sold crude to cement mills.

Crude gypsum imported and uncalcined and calcined gypsum, from imported rock, sold or used in the United States, 1925–34, as reported to the Bureau of Mines by the importers

Year	Number of importers	Crude imported (short tons)	Sold or used by the importer				
			Without calcining		Calcined		Total value
			Short tons	Value	Short tons	Value	
1925–29 (average)	8	834,891	79,200	$353,963	659,504	$6,783,689	$7,137,652
1930	8	794,970	93,515	391,150	648,162	8,211,837	8,602,987
1931	8	630,892	78,258	317,190	538,633	7,602,117	7,919,307
1932	14	351,723	71,320	286,821	303,266	4,600,199	4,887,020
1933	13	340,337	70,338	282,775	238,733	3,433,959	3,716,734
1934	14	345,094	66,630	296,117	238,051	3,393,310	3,689,427

Exports.—The export business in gypsum products is of recent growth. Before 1913 American exports in this field were of negligible proportions; a maximum of $20,830 worth of plaster of paris was reported in 1912, practically all to Canada. Foreign sales aggregated $498,616 in 1925, rose to $955,169 in 1929, and subsequently dropped to a low point of $119,212 in 1933. Canada's place as leading customer for gypsum manufactures has been taken by the Philippine Islands. In recent years New Zealand also has been a large buyer, and Australia and several Asiatic countries have figured prominently in the trade. The Philippines recently have accounted for most of the shipments of raw gypsum, apparently land plaster exported from New York City, which is likewise the principal port of shipment of gypsum manufactures.

Gypsum and gypsum products exported from the United States, 1930–34

Year	Crude, crushed, or ground		Plaster board and wall board		Plaster, calcined, and manufactures, n. e. s.	
	Short tons	Value	Square feet	Value	Short tons	Value
1930	3,603	$22,918	16,677,518	$431,072	20,008	$397,810
1931	4,502	37,816	6,386,649	157,897	6,773	196,724
1932	3,580	18,931	1,981,685	46,175	1,339	72,094
1933	3,774	11,049	1,646,733	36,057	1,559	72,106
1934	2,614	12,165	1,895,700	43,041	2,239	78,286

WORLD PRODUCTION

The United States is easily the largest producer of gypsum and in addition to its own large output consumes the major part of the output of Canada, which is probably the third largest producer. France is normally the principal foreign source of the mineral; even the name "plaster of paris" attests the early importance of the gypsum deposits of the Montmarte section of the Paris Basin. The United Kingdom, Germany, and Spain have been rivals of Canada for third place, and it may be significant that the British output has been expanding in recent years somewhat more rapidly than that of other European countries. German statistics are somewhat fragmentary, and the real importance of the production of crude gypsum in Germany is not revealed fully by the figures in the accompanying world table because no account is taken of the gypsum consumed by various companies that mine the material for their own use. Most important of all is the consumption of the Merseburger chemical and cement industries, which probably consume in active years as much as 1,000,000 tons of gypsum annually.[12] A large number of other countries produce gypsum, but with the exception of Italy and perhaps of U. S. S. R. (Russia) none of them recently furnished as much as 500,000 tons annually.

World production of gypsum, 1930–34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
Algeria	94,780	91,120	90,550	86,220	(2)
Argentina [3]	49,449	39,473	33,543	34,805	(2)
Australia:					
New South Wales	2,914	1,766	2,481	2,307	(2)
South Australia	41,482	24,596	45,684	51,373	(2)
Victoria	5,902	1,590	2,951	5,214	(2)
Western Australia	1,606	226	3,706	2,653	(2)
Austria [4]	37,350	48,000	36,000	45,000	(2)
Canada	997,942	800,931	398,883	336,283	(5)
Chile	17,178	13,173	11,989	13,682	(2)
China	62,100	71,500	(6)	(6)	(2)
Cuba	27,200	(6)	(6)	(6)	(2)
Cyprus [7]	10,452	9,934	10,995	12,881	(2)
Egypt [8]	130,000	130,000	130,000	130,000	(2)
Estonia	1,963	7,851	8,299	5,670	(2)
France	3,055,420	2,832,280	(6)	(6)	(2)
Germany [9]	705,000	[9] 490,000	398,500	485,000	810,000
Greece	1,365	3,200	2,167	(6)	(2)
India, British	57,220	54,493	52,246	33,674	(2)
Italy	685,530	587,845	529,821	534,026	(2)
Latvia [10]	35,272	31,431	36,812	48,251	82,800
Luxemburg	10,619	9,263	9,403	12,864	(2)
Morocco, French	167,270	70,400	(6)	(6)	(2)
New Caledonia	3,131	11,550	11,900	11,565	(2)
Palestine	1,661	491	1,481	2,602	(2)
Peru	14,412	8,603	(6)	(6)	(2)
Poland	40,000	24,000	(6)	(6)	(2)
Rumania	51,252	53,003	40,018	57,094	(2)
Spain	1,582,604	827,282	697,230	709,246	(2)
Sweden	135	50	115	49	(2)
Tunisia	20,000	17,450	26,000	17,580	(2)
Union of South Africa	17,098	14,847	7,113	11,809	(2)
United Kingdom:					
Great Britain	851,468	767,011	1,011,399	1,000,865	(2)
Northern Ireland	193	(6)	41	(6)	(2)
United States	3,149,178	2,321,489	1,284,815	1,211,259	1,393,583
Yugoslavia [11]	1,463	836	(6)	842	(2)
	11,900,000	9,400,000	7,600,000	7,600,000	(2)

[1] In addition to the countries listed gypsum is produced in Japan, Switzerland, and the U. S. S. R. (Russia), but production data are not available.
[2] Data not available.
[3] Rail and river shipments.
[4] Estimate furnished by Bundesministerium für Handel und Verkehr.
[5] Data for crude gypsum mined not available. Shipments of crude (lump, crushed, and ground) and calcined gypsum amounted to 418,386 tons.
[6] Data not available; estimate included in world total.
[7] Exports of crude and calcined gypsum.
[8] Approximate production.
[9] Figures supplied by Deutscher Gips-Verein, E. V., Berlin, Germany. Figures are exclusive of rock gypsum mined and used by cement, paint, and other factories from their own quarries, which is estimated to have amounted to 1,000,000 tons in 1930.
[10] Exports.
[11] Serbia only.

[12] Martin, Louis, Bauberatungsstelle der deutschen Gipsindustrie in Arnstadt (letter dated Mar. 31, 1932).

THE INDUSTRY IN FOREIGN COUNTRIES

World trade in crude gypsum is restricted because of the low unit value of the material and its wide distribution. The heaviest movement is between Canada and the United States; next in importance is the importation into Belgium, amounting in 1929 to well over 200,000 tons. Czechoslovakia is a substantial buyer of calcined gypsum; and most of the nations of continental Europe, as well as many overseas countries, import 5,000 to 20,000 tons of gypsum or its products annually. Both Canada and the United States formerly enjoyed a good export business with Australia and New Zealand, but this is dwindling somewhat in recent years, due to exchange and other difficulties. Of especial interest at the present time is the flow of gypsum into the United Kingdom. In 1929, for example, British imports were over 80,000 tons, most of which came from France and Germany; but in 1934 shipments were made to a London firm from Nova Scotia, and this business is expected to develop into an important addition to Canadian trade.

Aside from Canada the leading world exporters of raw gypsum are France and Germany. In 1929 the former shipped 360,000 tons and the latter nearly 150,000 tons to other countries. Algeria also exports a portion of its output. As previously indicated, Mexico supplies some tonnage from its Lower California deposits to American gypsum plants on the Pacific coast, and a growing trade with China is considered a possibility. A little gypsum has been produced in China but, in certain localities, at least, only at very high cost.

Canada.—Canada is supplied abundantly with gypsum deposits. Those in the Maritime Provinces—Nova Scotia and New Brunswick—are mainly on tidewater or close to it and are primarily producers of crude rock for export. On the other hand, the deposits in the Provinces of Ontario, Manitoba, and British Columbia lie within easy reach of large centers of domestic consumption for prepared gypsum products, and the bulk of their production goes into the manufacture of plaster, wall board, blocks and tiles, and insulating products in Canada.[13] In 1934 production of crude gypsum in the Dominion rose 20 percent above the low point reached during the previous year. Exports representing 77 percent of the output accounted for most of the improvement, as local building continued in a greatly depressed state. Highly significant was the clearing in June of two steamers for London, England, from Cheticamp, N. S., with the first large shipments of crude gypsum for the United Kingdom. The Department of Mines, Ottawa, reports that these shipments are forerunners of regular loadings by the Atlantic Gypsum Products Co. to British markets. The new wall-board plant at Rochester, Kent, England, is operated by Gyproc Products, Ltd., affiliated with Gypsum, Lime & Alabastine (Canada), Ltd., and is of American design; its supply of calcined gypsum is imported.

France.—The most productive gypsum deposits in France are in the Paris Basin; Montmartre, Pantin, Belleville, Sannois, and Enghienles

[13] Cole, L. H., Recent Trends in the Gypsum Industry in Canada: Paper read at February 1935 meeting of Am. Inst. Min. and Met. Eng., New York.

Bains are important centers. High-grade alabaster is mined near Lagny in the Department of Seine-et-Marne. Much smaller quantities are obtained from deposits in southeastern France in the Departments of Ariège, Charente, Nièvre, Savoie, Jura, Saône-et-Loire, Basses-Pyrénées, and Bouches-du-Rhone. In 1913 France produced about 2,000,000 tons of gypsum, of which 170,000 tons were exported; a maximum of over 3,000,000 tons was produced in 1930, and recently exports have been roughly twice as much as they were before the World War, having increased faster even than domestic consumption. Whole trainloads of gypsum have been employed in recent years by the Office National Industriel d'azote à Toulouse (formerly Poudrerie d'Empalot) for making sulphate of ammonia.

France controls important additional resources in Algeria, where gypsum is quarried on a large scale in the Provinces of Constantine and Oran.

Germany.—The production of crude gypsum in pre-war Germany has been estimated at 100,000 tons annually [14] principally from Bavaria and Baden. However, official figures, except for two or three individual States, still are lacking, and there is a possibility that Germany is a much larger factor in the gypsum industry than is generally known. Domestic consumption and exports have increased greatly, and in addition to being used for making plaster of paris and the ordinary run of calcined gypsum products, gypsum is used in Germany, more perhaps than in any other country, as a source of both lime and sulphur for chemicals. By 1928 the Dye Trust's former Bayer plant at Leverkusen was producing sulphuric acid at the rate of 40,000 to 50,000 tons annually (with prospects of expansion) by heating gypsum, clay, and coal, with additions of sand and slag, in revolving kilns.[15] The sulphur dioxide released from the gypsum is reoxidized to sulphuric acid, and portland cement is obtained as a byproduct. It has been reported [16] that the cost of converting ammonia into ammonium sulphate by the gypsum process was 132.85 reichsmarks compared with 240.40 reichsmarks by the usual method of direct combination with acid.

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[14] Imperial Mineral Resources Bureau, Gypsum (1913–1919): London, 1923, p. 19.

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LIME [1]

By Oliver Bowles and A. T. Coons

SUMMARY OUTLINE

The conviction expressed a year ago that the lime industry was definitely on its way toward recovery is confirmed by preliminary figures for 1934, which show gains of 6 percent in quantity and 19 percent in value of sales compared with 1933. The lime industry was among the first of the nonmetallic-minerals group to be granted a code by the N. R. A., and leaders in the industry accord much credit to the code for the encouraging increase in activity since 1932, the low year of the depression. As a result of the moderate recovery in construction the quantity of building lime sold in 1934 increased 5 percent compared with 1933. The chemical industries (other than dead-burned dolomite), which were fairly active, consumed 5.5 percent more lime than in 1933. The substantial increase in output of iron and steel during the year was reflected in a gain of 18 percent in sales of dead-burned dolomite for furnace refractory. The tonnage of agricultural lime sold decreased 1 percent; this was the only major branch of the industry that declined in 1934.

The following table summarizes data of the lime industry for 1933 and 1934:

Salient statistics of the lime industry in the United States, 1933–34

	1933	1934 [a]	Percent of change in 1934
Sales by producers:			
Total lime:			
Short tons	2,269,280	2,407,000	+6.1
Value	$14,253,659	$16,996,000	+19.2
Per ton	$6.28	$7.06	+12.4
Hydrated lime (included in total):			
Short tons	840,007	830,000	−1.2
Value	$5,622,026	$6,346,000	+12.9
Per ton	$6.69	$7.65	+14.3
By uses:			
For building:			
Short tons	533,088	558,000	+4.7
Value	$3,828,594	$4,529,000	+18.3
Per ton	$7.18	$8.12	+13.1
For agriculture:			
Short tons	246,110	244,000	−.9
Value	$1,318,247	$1,605,000	+21.8
Per ton	$5.36	$6.58	+22.8

[a] Subject to revision.

[1] Detailed figures for 1934, including final revisions, are given in the Statistical Appendix to Minerals Yearbook, 1935.

Salient statistics of the lime industry in the United States, 1933–34—Continued

	1933	1934	Percent of change in 1934
Sales by producers—Continued.			
By uses—Continued.			
For chemical uses (exclusive of dead-burned dolomite):			
Short tons	1,228,270	1,296,000	+5.5
Value	$7,041,949	$8,277,000	+17.5
Per ton	$5.73	$6.39	+11.5
Dead-burned dolomite:			
Short tons	261,812	309,000	+18.0
Value	$2,064,869	$2,585,000	+25.2
Per ton	$7.89	$8.37	+6.1
Imports:			
Quicklime and hydrated lime:			
Short tons	10,505	9,232	−12.1
Value	$105,264	$83,319	−20.8
Per ton	$10.02	$9.03	−9.9
Dead-burned dolomite:			
Short tons	6,763	6,473	−4.3
Value	$163,081	$166,912	+2.3
Per ton	$24.11	$25.79	+7.0
Exports (lime):			
Short tons	3,710	3,752	+1.1
Value	$58,095	$60,167	+3.6
Per ton	$15.66	$16.04	+2.4

Production by States.—Ohio was the leading State in total production of lime and also in production of hydrated and building lime. Preliminary figures for 1934 show total sales of 549,000 short tons valued at $4,153,000, a decrease of 2 percent in quantity but an increase of 24 percent in value compared with 1933. Sales of hydrated lime, of which about 80 percent was used in construction, were reported as 226,000 tons valued at $1,759,000, a decrease of 13 percent in quantity but an increase of 16 percent in value. The State total output included 228,000 tons of building lime valued at $1,752,000, an increase of 5.6 percent in quantity and 34 percent in value; 29,000 tons of agricultural lime valued at $178,000, a decrease of 46 percent in quantity and 2.6 percent in value; 164,000 tons of dead-burned dolomite valued at $1,426,000, an increase of 23 percent in quantity and 26 percent in value; and 128,000 tons of lime valued at $797,000 sold to chemical industries, a decrease of 17 percent in quantity and 9 percent in value.

Pennsylvania ranked second in total production of lime in 1934 with an output of 441,000 tons valued at $3,110,000, an increase of 2 percent in quantity and 11 percent in value over 1933. It was second also in output of hydrated lime, producing 140,000 tons valued at $1,110,000, an increase of 0.8 percent in quantity and 14 percent in value. Usually about 60 percent of the lime, including dead-burned dolomite, manufactured in Pennsylvania, is used in metallurgical and chemical processes; such sales declined about 11 percent in 1934. Sales of lime for agricultural uses increased 12 percent, and those for construction were about the same as in 1933.

The following table gives production by States in 1933 and 1934:

Lime sold by producers in the United States, 1933–34, by States

State	1933				1934 [1]			
	Total lime		Hydrated lime		Total lime		Hydrated lime	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Ohio	558,901	$3,353,102	259,233	$1,519,716	549,000	$4,153,000	226,000	$1,759,000
Pennsylvania	433,795	2,810,758	138,914	973,762	441,000	3,110,000	140,000	1,110,000
Missouri	230,051	1,121,295	91,240	524,115	284,000	1,510,000	96,000	590,000
West Virginia	121,473	655,303	28,017	169,244	140,000	859,000	29,000	195,000
Tennessee	119,587	548,242	27,409	185,132	126,000	653,000	30,000	216,000
Alabama	107,810	565,384	21,184	130,872	122,000	745,000	19,000	135,000
Virginia	84,597	487,957	36,645	234,994	94,000	610,000	42,000	289,000
Illinois	81,888	575,862	24,491	172,627	88,000	665,000	25,000	187,000
Indiana	64,479	355,720	30,730	185,718	68,000	415,000	30,000	200,000
Massachusetts	56,941	481,487	22,142	173,474	50,000	447,000	20,000	154,000
Michigan	43,959	292,144	9,111	74,573	43,000	319,000	6,800	54,000
Texas	36,286	339,035	20,351	211,347	37,000	358,000	19,000	200,000
California	35,754	342,999	11,334	110,414	35,000	361,000	10,000	112,000
New York	36,369	286,625	11,634	89,246	34,000	285,000	13,000	108,000
Wisconsin	28,909	220,465	7,304	54,319	33,000	273,000	8,800	69,000
Vermont	28,509	196,532	8,468	51,969	31,000	237,000	9,800	73,000
Maryland	26,469	154,318	15,300	96,440	29,000	202,000	18,000	133,000
Washington	17,214	170,281	2,637	27,957	22,000	234,000	2,800	31,000
Other	156,289	1,296,150	73,863	636,107	181,000	1,560,000	84,800	731,000
Total	2,269,280	14,253,659	840,007	5,622,026	2,407,000	16,996,000	830,000	6,346,000

[1] Subject to revision.

Market channels.—Statistics on sales of lime by uses for a period of years afford a ready means of studying trends in utilization. Analyses of these trends, particularly of the causes for fluctuations in quantities sold for the various uses, add greatly to the usefulness of such statistics. Statistics of consuming industries also are essential to an intelligent study of trends in the uses of lime, as fluctuations usually are linked with the ebb and flow of activity in these industries. For example, sales of building lime conform in general to the floor space of new buildings or the value of building contracts awarded and sales of metallurgical and refractory lime to volume of steel-ingot production.

To assist lime companies in mapping sales programs and planning future activities, the Bureau of Mines has devoted considerable attention to trade trends. Some of the results of these studies appear in a recent report,[2] which includes tables on sales of lime by uses, figures showing the relation of sales to activity in the capital-goods and consumers'-goods industries, charts showing trends in sales compared with trends in various consuming industries, and discussions of the many problems involved. Some phases of lime consumption are discussed in the following section.

Consumption by uses.—Lime is an important raw material in numerous industries. For many years it was used chiefly by the building trades, but, with minor fluctuations, a steady trend toward wider use by the chemical and manufacturing industries has taken place. In 1906, the first year for which sales of lime were reported by uses, 86 percent by value was used in building and only 8 percent in chemical and manufacturing processes; in 1934 only 27 percent by value was used in building but 64 percent in chemical and manufacturing

[2] Hatmaker, Paul, Trade Trends in the Lime Industry: Rept. of Investigations 3227, Bureau of Mines, 1934, 17 pp.

processes. The use of lime in agriculture has shown only slight changes; in 1906 about 6 percent was so used and in 1934 about 9 percent.

Figure 101 shows principal trends of the lime industry, 1907–34. In 1925 the building trades consumed more than half of all lime sold; in 1934 they used less than one-fourth. The trend from building to chemical uses since 1928 has been accelerated by the small volume of building and the relatively greater activity in the chemical and allied industries. The use of lime in agriculture has been sustained remarkably well considering the low buying power of farmers during recent years.

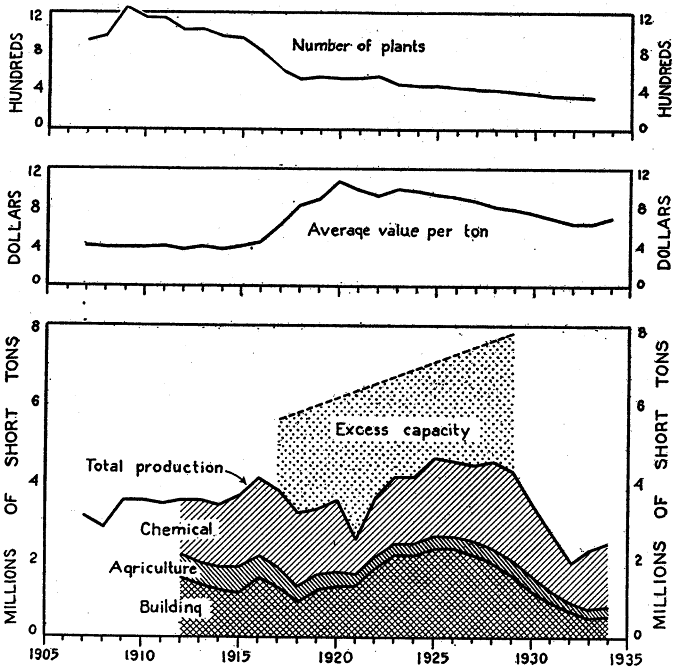

FIGURE 101.—Principal trends of the lime industry, 1907–34. Estimates of productive capacity are available for only 2 years—1917 and 1929.

Figure 102 compares sales of building lime with construction contracts awarded from 1925 to 1934. Sales of building lime decreased steadily for 3 years before the decline in construction began, and, for the entire period covered in the chart, lime failed to attain the importance in the building trades that it had held before 1925. This condition probably was due chiefly to competition with other mortar, plaster, and plaster-board products.

Figure 103 shows trends in sales of lime for the metallurgical and principal chemical uses from 1924 to 1933. Sales to the consumers'-goods industries in this group showed marked resistance to the effects of the depression. Sales to the paper industry declined only moderately; in 1932, the low point of the depression, they were about 40 percent below those in 1927, the peak year, but in 1933 they gained substantially. There was little change in the quantity of lime used in water treatment, because the welfare of communities demands that water supplies be treated in times of business depression just as in times of prosperity. The increase in 1933 indicates that more municipal water supplies were being treated than in former years. Sales of lime to tanneries and glass works remained comparatively

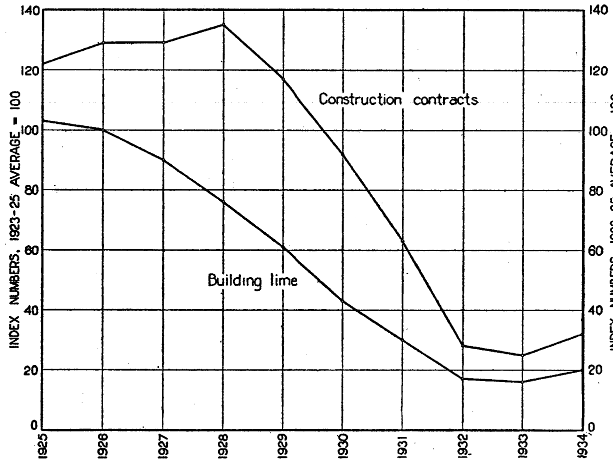

FIGURE 102.—Value of sales of building lime compared with value of construction contracts awarded, 1925–34. To facilitate comparison unlike units have been reduced to percentages of the 1923-25 average. Statistics for lime are from the Bureau of Mines; those for construction compiled by the Federal Reserve Board from data of the F. W. Dodge Corporation.

constant until 1932 and increased somewhat in 1933. The increased demand from the glass trade was due to the boom in bottle manufacture that followed the repeal of the eighteenth amendment and to the marked increase in the manufacture of plate glass for automobiles.

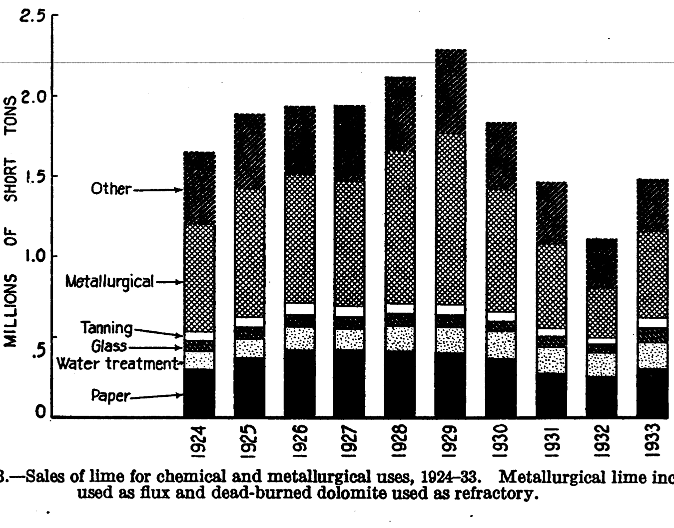

FIGURE 103.—Sales of lime for chemical and metallurgical uses, 1924–33. Metallurgical lime includes lime used as flux and dead-burned dolomite used as refractory.

The fluctuations in sales of lime for metallurgical uses, which depend upon activity in the capital-goods industries, contrast strikingly with the relatively small changes from year to year in sales of lime for the principal chemical uses. Sales of metallurgical lime dropped sharply from 1929 to 1932 but increased in 1933 because of the renewed activity in steel plants during the last 6 months of the year.

Figure 104 illustrates the dependence of sales of fluxing and refractory lime on the output of steel ingots. An interesting feature is the greater proportionate gain in sales of dead-burned dolomite than in production of steel ingots in 1933. This situation may be explained by the fact that the quickened demand for steel in the latter half of the year created an unusual demand for refractories to recondition furnaces that had been idle during the lean months. The rapid gain in sales of dead-burned dolomite continued in 1934. The 1934 figures for fluxing lime are not yet available.

Figure 105 illustrates graphically trends in some of the minor uses of lime from 1924 to 1933. As explained in the discussion of major uses, those branches of the lime industry that depend most upon

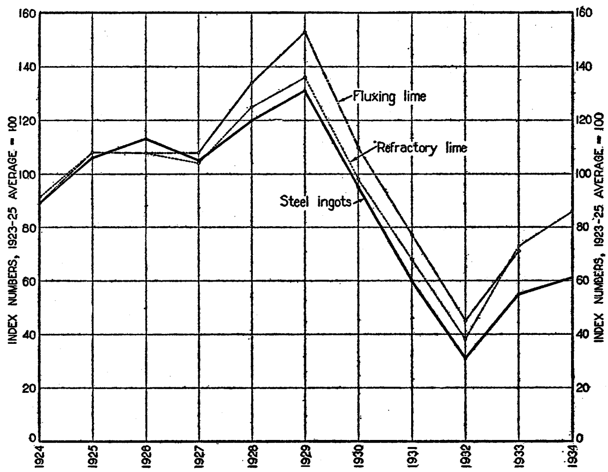

FIGURE 104.—Sales of fluxing and refractory lime compared with steel-ingot production, 1924–34. To facilitate comparison unlike units have been reduced to percentages of the 1923–25 average. Data on production of steel ingots compiled by American Iron and Steel Institute.

building and the capital-goods industries have suffered in general the most serious declines in recent years. The demand for sand-lime and slag brick—products used chiefly in building—diminished greatly after 1928. The demand for lime for silica brick, which are used principally as refractories in metallurgical furnaces, also declined considerably after 1929; the upturn in 1933 reflects the recovery in steel production. The other uses shown in figure 105 have to do with the nondurable-goods industries, which in general have shown greater stability.

The curves for the minor uses may be somewhat inaccurate because many companies in filling out their schedules give little attention to minor sales. The violent fluctuations in the soap and alkali curves, for example, are probably due to insufficient returns. Although based upon incomplete statistics, the curves nevertheless indicate general trends.

Prices.—The steady downward trend in prices of lime that began about 1923 was halted in 1932. The average value per ton was unchanged from 1932 to 1933 but moved upward decisively in 1934.

Figure 106 shows prices of lime compared with those of all commodities, building materials, and chemicals from 1925 to 1934.

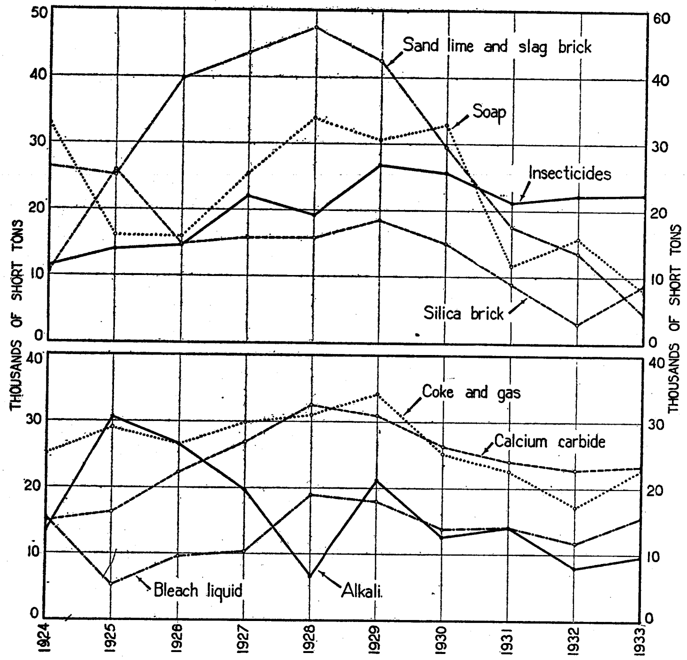

FIGURE 105.—Trends in minor uses of lime, 1924–33.

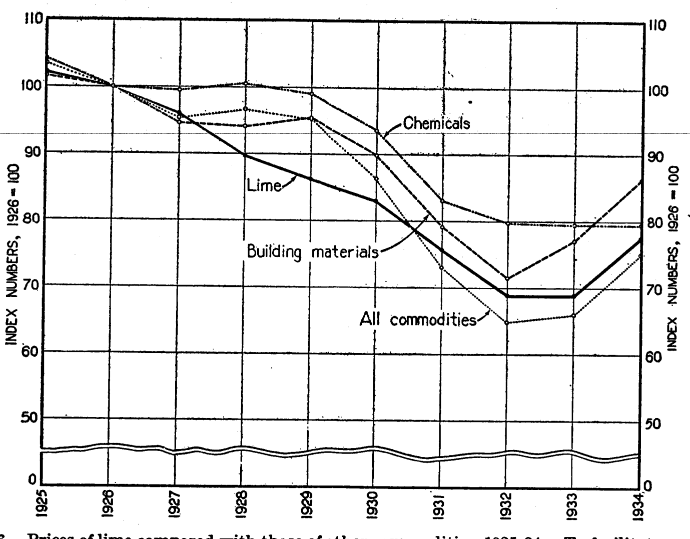

FIGURE 106.—Prices of lime compared with those of other commodities, 1925–34. To facilitate comparison prices have been reduced to percentages of the 1926 average. Index numbers of lime compiled by the Bureau of Mines; those of other commodities by the Bureau of Labor Statistics.

The price of lime recovered a little more in 1934 than the average of all commodities but not so much as that of all building materials, and the average value per ton was still considerably below values prevailing in predepression years.

Specifications.—Committee C-7 on Lime of the A. S. T. M. was active during 1934 in revising specifications. The following tentative revisions were prepared and published: Methods of Physical Test for Limestone, Quicklime, and Hydrated Lime (C25-T); Specifications for Hydrated Lime for Structural Purposes (C6-T); and Specifications for Quicklime for Structural Purposes (C5-T).

CODE DEVELOPMENTS

The original code of fair competition for the lime industry contained certain defects and ambiguities that required correction. During 1934 it was revised thoroughly, and an amended code approved April 1, 1935, became effective April 11, 1935. The purpose of most of the amendments was to clarify the major provisions in the light of experience gained by the industry. Much careful effort was given to this revision.

A central basing point for rail shipments is established by the district central committee for all lime plants in a given district; however, a manufacturer may establish his plant as his rail basing point if he so desires, but he must notify the district central committee of such action. For shipments by water or highway each plant is its own basing point. The area around each established basing point having the advantage of the lowest freight rate is designated a "low-rate area." Each firm must file with the code authority complete price terms for all lime products manufactured and offered for sale. For rail shipments, such price terms are to be f. o. b. the established basing points. For mill pick-ups and water or truck deliveries, the terms are to be f. o. b. plant. For shipments to points beyond its own low-rate area, each firm may use the published price terms and freight rate in effect at the basing point of the low-rate area in which the destination falls. This provision permits operators to meet competitive prices. However, to discourage excessive cross-haulage and to limit the amount of freight absorbed, the amended code carries a provision that the net price realized at the plant for any shipment should be not less than 80 percent of the price filed at the shipper's basing point. This provision, however, is stayed in the order of approval pending further study and report as to its effect upon the industry.

Although a multiple basing-point system is used, it is important to note that it is a permissive system designed to be fair and reasonable to all parties concerned. It is clearly the intent of the code to maintain a free and open market, for it forbids agreements to fix or maintain prices. Article VIII, section 5, relative to this question is as follows:

> No Member of the Industry shall enter into any agreement, understanding, combination, or conspiracy to fix or maintain price terms, nor cause or attempt to cause any Member of the Industry to change his price terms by the use of intimidation, coercion, or any other influence inconsistent with the maintenance of the free and open market which it is the purpose of this article VIII to create.

The original code provided for determination of a weighted average cost for each product in each district, such cost to be used as a basis for computing minimum prices. This provision was not put into effect and is abandoned in the revised code. The new code provides that a uniform method of cost accounting is to be established and used as far as practicable as a basis for price determination. Machinery is established whereby the problem of destructive price cutting may be met by declaring an emergency. Sections dealing specifically with this problem read as follows:

> Wilfully destructive price cutting is an unfair method of competition and is forbidden. Any Member of the Industry or of any other Industry, or the customers of either, may at any time complain to the Code Authority that any filed price constitutes unfair competition as destructive price cutting, imperiling any enterprise, large or small, or tending toward monopoly or the impairment of code wages and working conditions. The Code Authority shall, within five (5) days, afford an opportunity to the member filing the price to answer such complaint and shall, within fourteen (14) days, make a ruling or adjustment thereon. If such ruling is not concurred in by either party to the complaint, all papers shall be referred to the Research and Planning Division of N. R. A. which shall render a report and recommendation thereon to the Board.
>
> If the Board, after investigation, shall at any time find both (1) that an emergency has arisen within any designated area adversely affecting any enterprise, large or small, or wages or labor conditions, or tending toward monopoly or other acute conditions which tend to defeat the purposes of the Act; and (2) that the determination of the stated minimum price for a specified product within such designated area for a limited period is necessary to mitigate the conditions constituting such emergency and to effectuate the purposes of the Act, the Code Authority may cause an impartial agency to investigate costs and to recommend to the Board a determination of the stated minimum price of the product affected by the emergency, and thereupon the Board may proceed to determine such stated minimum price.
>
> When the Board shall have determined such stated minimum price for a specified product for a stated period in such specified area, which price shall be reasonably calculated to mitigate the conditions of such emergency and to effectuate the purposes of the Act, it shall publish such price. Thereafter, during such stated period, no Member of the Industry shall sell such specified products in such specified area at a net realized price below said stated minimum price, and any such sale shall be deemed destructive price cutting. From time to time, the Code Authority may recommend review or reconsideration, or the Board may cause any determination hereunder to be reviewed or reconsidered and appropriate action taken.

FOREIGN TRADE [3]

Imports of lime for consumption in the United States declined 9 percent in quantity and 7 percent in value, from 17,268 short tons valued at $268,345 in 1933 to 15,705 tons valued at $250,231 in 1934. Quicklime, hydrated lime, and dead-burned dolomite all shared in the decrease. More than 97 percent of the lime imported was shipped from western Canada for use in the State of Washington and in San Francisco.

Lime exported from the United States in 1934 increased 1 percent in quantity and 4 percent in value over 1933. Very little lime is exported; in 1934 such exports amounted to only 3,752 short tons valued at $60,167. The principal countries of destination were Dominican Republic, Peru, and Canada.

[3] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

CLAY

By Paul M. Tyler and R. W. Metcalf

SUMMARY OUTLINE

The clay-production figures of the Bureau of Mines represent chiefly clay mined and sold as clay, mined under royalty, or shipped into another State for fabrication. This classification includes most of the high-grade kaolins, ball clays, slip clays, and bentonites used for fine ceramic wares, paper making, and general industrial purposes and a considerable part of the fire clays but does not include bleaching clays, which are classified as "fuller's earth", or most of the clays and shales used in making heavy-clay products or portland cement.

Markets for fire clays and merchant clays generally were better in 1934 than in 1933. The pottery trade, although still in the doldrums, improved, and the enamelware industry was rather active. Paper manufacture slowed down in the autumn, and production for the year probably receded somewhat; sales of domestic clay to the paper industry, accordingly, were slightly curtailed. Sales of refractories were better but were still depressed due to the continued low rate of steel production. Rubber-goods industries, on the other hand, were operating at a high rate due principally to a large jump in tire sales.

That the upturn in nonresidential building construction brought moderate relief to the heavy-clay-products industries is indicated by increases of 2.7 points in the employment index and 4 points in the pay-roll index for brick, tile, and terra cotta as reported by the Bureau of Labor Statistics. The plight of these industries, however, is shown by the fact that in 1933 employment had declined to 27 percent of the 1923–25 average, while the pay-roll index had dropped to 12. A similar condition is revealed by figures of the Bureau of the Census which show a 70-percent drop in employment and declines of 80 or more percent in the volume of output of leading heavy-clay products. As the demand for common brick began to drop off before the depression affected other building materials, the upturn in 1934, accompanied as it was by rising prices, is encouraging, but these industries still have a long way to go before they can be described as prosperous. Preliminary figures show an output of at least 1,077,554 thousands of common brick valued at $11,202,305 in 1934 compared with 1,019,810 thousands valued at $8,816,452 in 1933 and 1,013,108 thousands valued at $8,705,405 in 1932. The production of face brick and hollow tile also increased in 1934, and notable reductions in stocks were recorded in practically every branch of the heavy-clay-products industry. Production trends in these items are shown in figure 108.

Imports of china clay slumped to only slightly more than the low tonnage of 1932, but their average value rose sharply to keep pace with the advance in dollar cost of sterling exchange. Better prices for exports in terms of our depreciated currency were accompanied by a small increase in tonnage of fire clay shipped abroad and a remarkable jump to an all-time record in exports of other clays.

Salient statistics of the clay industry in the United States, 1925–29 and 1931–34

	1925–29 (average)	1931	1932	1933	1934
Domestic clay sold for:					
Pottery and stoneware.....short tons..	225,910	147,409	108,135	114,022	110,915
High-grade tile.....do....	74,350	96,632	44,329	32,101	26,310
Saggers, spurs, stilts, wads.....do....	205,627	73,117	39,832	49,916	51,160
Architectural terra cotta.....do....	91,753	31,188	13,520	12,875	9,659
Paper.....do....	201,292	275,469	230,445	255,989	249,852
Rubber.....do....	31,996	34,501	33,719	49,615	48,259
Oilcloth and linoleum.....do....	11,885	7,411	5,326	6,715	9,061
Paints.....do....	18,047	12,920	7,983	10,859	11,869
Cement.....do....	70,913	121,196	50,281	22,747	24,581
Refractories.....do....	2,068,970	1,101,401	573,530	1,030,565	1,194,655
Miscellaneous.....do....	1,043,286	618,251	284,716	254,769	450,942
Total sold:					
Quantity.....do....	4,044,029	2,519,495	1,391,816	1,840,173	2,187,263
Value.....	$13,918,173	$8,352,185	$5,201,609	$6,840,617	$8,197,253
Imports:					
Kaolin, china clay.....short tons..	339,014	151,426	99,807	116,180	100,775
Common blue, Gross Almerode short tons..	12,130	15,183	5,880	7,099	9,467
Other clays:					
Crude.....do....	57,001	15,615	13,290	17,623	11,678
Washed, treated.....do....	4,047	[1] 8,376	[1] 8,133	[1] 9,756	[1] 9,226
Total imports:					
Quantity.....do....	412,192	190,600	127,110	150,658	131,146
Value.....	$3,715,725	$1,536,024	$877,180	$1,180,503	$1,341,524
Exports:					
Fire clay.....short tons..	55,316	45,314	22,086	32,432	36,053
Other clay.....do....	54,028	61,389	59,273	66,093	84,264
Total exports:					
Quantity.....do....	109,344	106,703	81,359	98,525	120,317
Value.....	$1,217,769	$1,244,855	$1,054,623	$1,234,888	$1,455,979

[1] Includes "acid-treated earths" after June 17, 1930.

DOMESTIC PRODUCTION

In 1934 shipments of virtually all kinds of clay continued the recovery begun in 1933 and regained much of the losses suffered in 1932. Output of bentonite soared to an all-time high, and every item except ball clay showed appreciable increases over the figures of the previous year. Even for ball clay a slight drop in tonnage shipments was offset by an increase in their aggregate value. Changes in the quantity of so-called "miscellaneous clay" are of less significance than those in other categories because this group contains a larger number of more or less self-contained enterprises whose clay consumption from year to year includes varying quantities procured from sources not covered by the Bureau of Mines canvass.

Clay sold by producers in the United States, 1909–13 and 1925–34, by kinds

Year	Kaolin or china clay and paper clay		Ball clay		Slip clay		Fire clay	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1909–13 (average)	132, 114	$705, 352	63, 371	$231, 477	14, 268	$25, 867	1, 629, 098	$2, 261, 738
1925–29 (average)	453, 618	3, 834, 285	116, 127	890, 457	6, 839	37, 000	2, 810, 001	7, 747, 918
1930	533, 800	3, 893, 814	93, 488	739, 787	4, 398	26, 465	2, 547, 162	6, 070, 663
1931	443, 300	2, 946, 953	83, 007	639, 798	1, 916	13, 613	1, 473, 161	3, 741, 038
1932	344, 994	2, 011, 208	47, 573	312, 751	525	5, 105	725, 993	2, 057, 060
1933	411, 233	2, 366, 339	64, 551	400, 564	1, 562	11, 365	1, 133, 693	3, 141, 545
1934	426, 335	2, 699, 016	62, 877	423, 421	5, 117	35, 832	1, 288, 909	3, 733, 033

Year	Stoneware clay		Bentonite		Miscellaneous clay		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1909–13 (average)	142, 569	$143, 034	(1)	(1)	400, 546	$369, 019	2, 381, 966	$3, 736, 487
1925–29 (average)	88, 575	188, 055	(1)	(1)	568, 869	1, 220, 458	4, 044, 029	13, 918, 173
1930	75, 832	146, 513	107, 405	$858, 927	600, 818	785, 326	3, 962, 903	12, 521, 495
1931	57, 466	131, 915	78, 815	472, 045	381, 830	406, 823	2, 519, 495	8, 352, 185
1932	49, 736	82, 521	71, 613	503, 673	151, 382	229, 291	1, 391, 816	5, 201, 609
1933	28, 188	59, 581	117, 428	760, 174	83, 518	101, 049	1, 840, 173	6, 840, 617
1934	56, 678	100, 279	215, 339	1, 050, 578	132, 008	155, 094	2, 187, 263	8, 197, 253

1 Sales of bentonite included under "Miscellaneous clay" before 1930 when separate figures first became available.

Clay sold by producers in the United States in 1934, by States and kinds

State	Number of active establishments reporting sales	Kaolin or china clay and paper clay		Ball clay		Fire clay		Stoneware clay		Miscellaneous clay [1]		Total	
		Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	11					33,916	$45,284			2,656	$1,142	36,572	$46,426
Arizona	4					([2])	([2])			([2])	([2])	([2])	([2])
California	43	1,572	$12,229			74,340	163,695	1,567	$5,797	128,455	319,075	205,934	500,796
Colorado	14					30,601	43,599			8,814	8,875	39,415	52,474
Connecticut	3					([2])	([2])			([2])	([2])	([2])	([2])
Delaware	2	2,127	28,718									2,127	28,718
Florida	2	([2])	([2])									([2])	([2])
Georgia	17	284,556	1,621,223									284,556	1,621,223
Idaho	2					282	3,655					282	3,655
Illinois	15			([2])	([2])	62,341	135,647	([2])	([2])	([2])	([2])	69,921	160,537
Indiana	18					31,304	43,962	239	844	35,702	33,323	67,245	78,129
Iowa	10					1,255	11,651			1,017	10,591	2,272	22,242
Kentucky	17			29,398	$216,684	111,444	390,019					140,842	606,703
Maine	2									([2])	([2])	([2])	([2])
Maryland	9			([2])	([2])	11,408	42,545			([2])	([2])	22,700	78,604
Massachusetts	6					([2])	([2])	([2])	([2])	([2])	([2])	1,014	12,761
Michigan	2									([2])	([2])	([2])	([2])
Minnesota	3					([2])	([2])	([2])	([2])	([2])	([2])	([2])	([2])
Mississippi	1							([2])	([2])			([2])	([2])
Missouri	49	([2])	([2])	([2])	([2])	222,403	957,349					223,022	961,854
Montana	6					([2])	([2])			([2])	([2])	2,675	4,800
Nebraska	4					50	150			8,956	6,076	9,006	6,226
New Jersey	27			1,537	11,202	59,404	254,649	3,980	15,253	3,870	8,437	68,791	289,541
New Mexico	4					1,411	6,081					1,411	6,081
New York	6					([2])	([2])					5,390	39,067
North Carolina	5	7,146	106,742									7,146	106,742
North Dakota	2					([2])	([2])			([2])	([2])	([2])	([2])
Ohio	57					192,621	452,294	11,061	13,506	494	2,029	204,176	467,829
Oklahoma	3									8,502	84,241	8,502	84,241
Oregon	1					([2])	([2])					([2])	([2])
Pennsylvania	78	22,219	67,779			385,471	1,002,344	26,941	41,554	15,293	15,100	449,924	1,126,777
South Carolina	10	90,794	658,905			371	3,737					91,165	662,642
South Dakota	2					([2])	([2])			([2])	([2])	([2])	([2])
Tennessee	8			23,587	151,808	16,375	55,956	175	219	7,528	7,528	47,665	215,511
Texas	11					19,907	38,694			35,326	235,375	55,233	274,069
Utah	6					([2])	([2])			([2])	([2])	20,036	138,231
Vermont	1	([2])	([2])									([2])	([2])
Virginia	3	([2])	([2])			([2])	([2])			([2])	([2])	5,099	33,892
Washington	9	50	250			772	1,452	2,556	1,656	14,323	11,002	17,701	14,360

West Virginia	4					28,658	51,250					28,658	51,250
Wyoming	5									27,162	246,562	27,162	246,562
Undistributed		17,871	203,170	8,355	43,727	4,575	29,020	10,159	21,450	54,366	252,148	41,621	255,310
1934 Total	482	426,335	2,699,016	62,877	423,421	[3] 1,288,909	[3] 3,733,033	56,678	100,279	[4] 352,464	[4] 1,241,504	2,187,263	8,197,253
1934 Average value per ton			6.33		6.73		2.90		1.77				3.75
1933 Total	481	411,233	2,366,339	64,551	400,564	[3] 1,133,693	[3] 3,141,545	28,188	59,581	[5] 202,508	[5] 872,588	1,840,173	6,840,617
1933 Average value per ton			5.75		6.21		2.77		2.11				3.72

[1] Includes adobe, shale, etc. Slip clay and bentonite are also included in this column as a matter of statistical convenience.
[2] Included under "Undistributed."
[3] Fire-clay totals include diaspore and burley clay from Missouri, as follows: 1934, 20,294 tons, valued at $104,692; 1933, 11,809 tons, $53,485.
[4] Includes 5,117 tons of slip clay valued at $35,832, from Michigan and New York, and 215,339 tons of bentonite valued at $1,050,578 from Arizona, California, Oklahoma, South Dakota, Texas, Utah, and Wyoming. Of the total bentonite California reported 108,924 tons, valued at $291,857; Oklahoma, 6,529 tons, $73,156; Texas, 35,248 tons, $235,194; and Wyoming, 27,161 tons, $246,548.
[5] Includes 1,562 tons of slip clay, valued at $11,365 and 117,428 tons of bentonite valued at $760,174.

High-grade Georgia kaolin, valued in 1934 at $6.49 a ton, commonly is sold for paper, china, and other similar purposes. Other so-called "kaolin" valued at only $1.80 a ton in 1934 has been used for refractories. The following table gives production and value of Georgia kaolin, by uses, from 1930 to 1934.

Georgia kaolin sold or used, 1930–34, by uses

Year	China clay, paper clay, etc.			Refractory uses			Total kaolin		
	Short tons	Value		Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton		Total	Average per ton
1930	240,734	$1,977,457	$8.21	49,146	$83,752	$1.70	289,880	$2,061,209	$7.11
1931	245,304	1,602,248	6.53	32,498	54,185	1.67	277,802	1,656,433	5.96
1932	207,519	1,148,000	5.53	26,725	48,988	1.83	234,244	1,196,988	5.11
1933	239,271	1,342,512	5.61	40,767	75,108	1.84	280,038	1,417,620	5.06
1934	236,606	1,535,046	6.49	47,950	86,177	1.80	284,556	1,621,223	5.70

IMPORTS AND EXPORTS [1]

Before the outbreak of the World War more than two-thirds of the china clay used in the United States was English clay, and as recently as 1925 imports of this general class of clay exceeded domestic production. Replacement of foreign by domestic clays in the paper and pottery industries continued unabated during the depression, and in 1934 imports of china clay constituted less than 20 percent of the apparent consumption. Imports of common blue and Gross-Almerode clay included 56 short tons of processed clay valued at $1,191 or $21 a ton, which is about double the average value of the unwrought clay imported under this category.

Depreciation in the international exchange value of the dollar was reflected in the foreign trade figures for 1934, and in considering the increase in value of clay imports it must be remembered that the British pound sterling advanced from an average of $4.22 in 1933 to $5.04 during 1934, or 20 percent. There was a noteworthy increase in exports of "clays other than fire clays" to 84,264 tons, a new high record. This classification, however, includes fuller's earth and similar earthy products and consequently is not comparable directly with the imports and domestic production figures presented in this chapter.

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Clay imported for consumption in the United States, 1909–13 and 1925–34

Year	Kaolin or china clay		Common blue and Gross-Almerode glass-pot clay		All other clays				Total	
					Unwrought		Wrought			
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1909–13 (average)	261,266	$1,562,684	19,763	$159,788	31,836	$126,313	1,423	$24,312	314,288	$1,873,097
1925–29 (average)	339,014	3,055,885	12,130	113,307	57,001	493,983	4,047	52,550	412,192	3,715,725
1930	236,251	2,197,540	18,900	154,428	24,883	209,175	[1] 4,984	[1] 143,817	[1] 285,018	[1] 2,704,960
1931	151,426	1,056,393	15,183	116,446	15,615	125,326	[1] 8,376	[1] 237,859	[1] 190,600	[1] 1,536,024
1932	99,807	461,191	5,880	45,445	13,290	90,140	[1] 8,133	[1] 280,404	[1] 127,110	[1] 877,180
1933	116,180	632,437	7,099	69,639	17,623	141,992	[1] 9,756	[1] 336,435	[1] 150,658	[1] 1,180,503
1934	100,775	752,993	9,467	111,828	11,678	120,738	[1] 9,226	[1] 355,965	[1] 131,146	[1] 1,341,524

[1] Includes "clays or earths, artificially activated with acid or other material", as follows: 1930 (June 18 to Dec. 31), 2,663 short tons valued at $100,779; 1931, 4,912 tons, $184,381; 1932, 7,328 tons, $267,560; 1933, 5,640 tons, $258,291; 1934, 3,867 tons, $232,664; not separately classified prior to change in tariff.

Domestic clay exported from the United States, 1925–34 [1]

Year	Fire clay		All other		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1925–29 (average)	55,316	$434,842	54,028	$782,927	109,344	$1,217,769
1930	62,660	519,788	73,870	1,108,586	136,530	1,628,374
1931	45,314	329,112	61,389	915,743	106,703	1,244,855
1932	22,086	228,073	59,273	826,550	81,359	1,054,623
1933	32,432	264,595	66,093	970,293	98,525	1,234,888
1934	36,053	308,424	84,264	1,147,555	120,317	1,455,979

[1] Statistics of exports of clays were not separately recorded before 1916. High unit value indicates processed clays, mainly filtering and decolorizing clays or fuller's earth, mainly from Pacific ports.

PRICES

The firmer tone in clay prices that developed in 1933 continued into 1934, and following adoption of the N. R. A. code by southern operators in September most kinds of Georgia and South Carolina clays were marked up $1 a ton. Wages, which had been about 13 cents and in some cases as low as 8 cents an hour, were boosted under the code to a minimum of 24½ cents an hour. The price changes, operators affirm, did not off-set higher costs, which resulted not only from the wage advance and revised schedule of working hours but also from increased cost of supplies. With few exceptions, clay miners reported better conditions in 1934 than in 1933, and prices realized for all kinds of clay, except perhaps bentonite, tended to be somewhat higher in 1934. Due to the growing practice of beneficiating clay at the mines, especially air reconditioning of the clay, trade-journal quotations are not compared readily over a period of years. Nevertheless, enough data are available to indicate that the upturn in 1934, although insufficient to cancel the rather moderate decline in prices after 1929, was definite enough to confirm the sentiment that the low point of the current depression in the clay industries has been passed.

Prices of various clays in the United States, 1931–34 [1]

	1931	1932	1933	1934	
				January	December
China clay, f. o. b. mines South Carolina and Georgia:					
Crude lump No. 1	$4.50–$5.00	$3.50–$6.00	$3.50–$4.00	(2)	(2)
Crushed	6.00– 8.00	4.50– 6.90	4.50– 5.00	[3] $5.00	[3] $6.00
Air-floated:					
No. 1	9.00–15.00	6.50–15.00	6.50–10.00	(2)	(2)
No. 2	5.50– 8.00	5.50– 6.00	5.50– 8.00	(2)	(2)
Florida, washed, crushed:					
Superwhite	12.50	11.75–12.50	11.75–12.75	12.75	12.75
Superplastic	12.00	11.25–12.00	11.75–12.75	12.75	12.75
Delaware, No. 1	14.50–15.00	13.00–14.50	14.00	14.00	14.00
English, f. o. b. United States port, lump, in bulk	15.00–25.00	12.00–21.00	14.00–18.00	$16.50–25.00	$15.00–22.00

[1] Metal and Mineral Markets quotations.
[2] Not quoted.
[3] Water-washed, $1.50 per ton extra; in paper bags, $2.50 extra.

Average values per short ton of various kinds of clay sold by producers in the United States, 1909–13 and 1925–34

Year	Kaolin and paper clay		Ball clay	Slip clay	Fire clay	Stoneware clay	All kinds of clay
	United States	South Carolina					
1909–13 (average)	$5.34	$3.88	$3.65	$1.81	$1.39	$1.00	$1.57
1925–29 (average)	8.45	8.93	7.67	5.41	2.76	2.12	3.44
1930	7.29	7.61	7.91	6.02	2.38	1.93	3.16
1931	6.65	6.84	7.71	7.10	2.54	2.30	3.32
1932	5.83	6.40	6.57	9.72	2.83	1.66	3.74
1933	5.75	5.99	6.21	7.28	2.77	2.11	3.72
1934	6.33	7.26	6.73	7.00	2.90	1.77	3.75

CONSUMPTION TRENDS

The Bureau of Mines has obtained data on the distribution of sales of domestic clay according to kinds and uses starting with 1921, but the figures for pottery clays, paper clays, and sundry minor items do not show consumption trends with even approximate accuracy, because imported clays also were being used extensively for these purposes. The clay chapter in Minerals Yearbook, 1934, contained charts comparing trends of domestic sales to specified industries with available indicators of consumption in these industries. A striking correlation between fire-clay sales and the index of iron and steel production was revealed, but sales of domestic clay for paper and rubber manufacture were shown to be increasing faster than the respective industrial barometers would indicate. In the rubber industry this condition is due to displacing more costly materials by clay in the vulcanizing batch, a trend that cannot continue indefinitely. In the paper industry, on the other hand, the trend in sales of domestic clay is exaggerated by the progressive displacement of foreign clays, which formerly supplied all of this market. The situation in 1929, as revealed by the Federal Census, shows purchases by the paper industry of 470,528 tons of clay valued at $7,120,281, of which domestic clay (as shown by reports of producers to the Bureau of Mines) constituted only 268,519 tons (57 percent). As domestic clays have been improved they have gained an increasingly larger share of the business since 1929, but the abnormal growth of domestic-clay sales to the paper industry eventually will strike a balance, and the Bureau of Mines figures then will become a better index of total consumption. In the pottery industry likewise sales of domestic clay represent an increasing proportion of the total clay consumed.

It should be noted, however, that domestic clay miners compete for business not only with foreign clay miners but also with sellers of other materials. In the rubber industry this has recently worked out to the advantage of the clay miners, but in the paper industry the possible substitution of competing materials is considered a perpetual menace. Talc, pyrophyllite, gypsum, calcium carbonate, and other filling materials are used instead of clays. At sulphite pulp mills, where lime mud is a waste product, the substitution of calcium carbonate has already had a perceptible effect upon clay sales; sizing problems and a patent situation are involved, but this material is manifestly much cheaper than clay delivered at the beaters, and clay

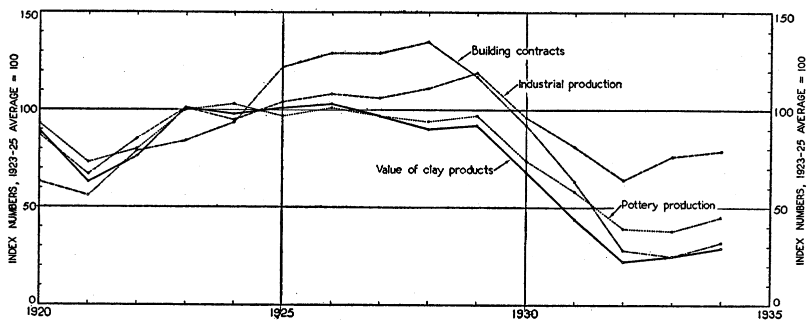

FIGURE 107.—Gross value of clay products and pottery production compared with building contract awards and index of industrial production, 1920–34.

miners accordingly have been able to hold some of this business only by improving their product constantly.

The refractories industries constitute the main outlet for the varieties of clay for which sales are reported by the Bureau of Mines. Additional clay is mined and made into fire brick and other products at the integrated establishments whose production is not reported, but these quantities are too small to obscure consumption trends as determined by actual sales data. In 1934 the sales of fire clay and total sales of clay for refractories industries rose 16 percent compared with a 12-percent increase in steel output and a rise of 6 points in the iron- and steel-production index of the Federal Reserve Board (from 53 in 1933 to 59 in 1934). The output of fire brick in 1934, however, was still 60 percent below the 1925–29 average.

Trends in the gross value of clay products and pottery production are compared with building contract awards and industrial production in figure 107.

Paper-trade indexes, formerly available, are no longer published. The industry slowed down in the autumn and did not pick up again much before the end of the year, and its purchases of domestic clay were a trifle smaller in 1934 than in 1933; significant, however, was a 14-percent increase in sales of domestic coating clay. The enamel-

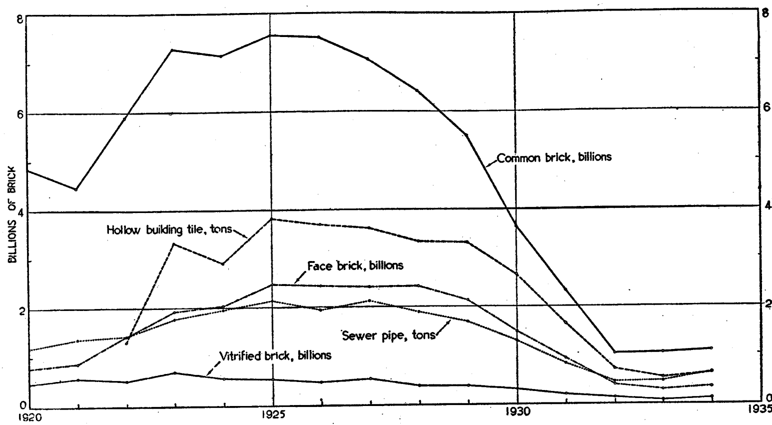

FIGURE 108.—Trends in production of heavy-clay products, 1920–34.

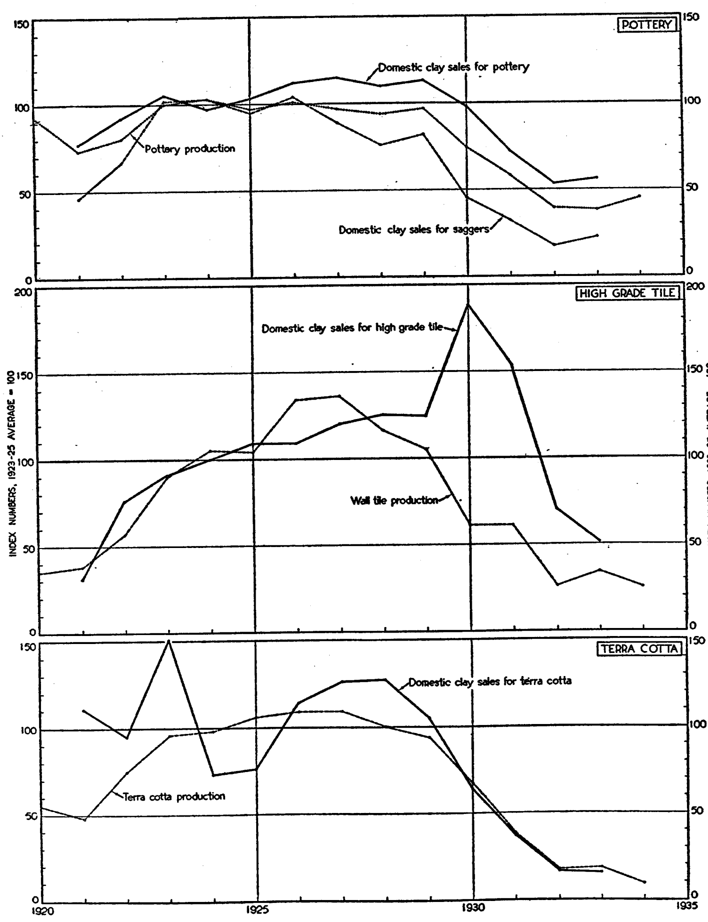

FIGURE 109.—Sales of domestic clay for pottery, high-grade tile, and terra cotta compared with output of finished products, 1920–34. Data on value of pottery, square feet of wall tile, and short tons of terra cotta are from the U. S. Bureau of the Census.

ware business, a small buyer of clay, was rather active in 1934, and the pottery trade, although still retarded, registered enough improvement to confirm the upturn noted in 1933. Tile and terra cotta, on the other hand, appeared to be still in light demand, and sales of clays to these industries remained far below the levels of predepression years.

The distribution of sales of domestic clay by kinds and uses, as reported by producers, is given in an accompanying table which continues the information published in former years. The Bureau of the Census publishes data covering the production of a large number of clay products, and trends in production of leading building material items and sewer pipe are shown in figure 108. Comparisons of Census of Manufactures data with sales of domestic clay as reported to the Bureau of Mines are shown for specified consuming industries in figure 109. The curves for pottery and stoneware indicate a somewhat larger proportion of domestic clays used in the ware, although the degree to which the imported clays have been displaced cannot be calculated from the available data, as only values are available to cover the production. The trend, however, is confirmed by the fact that purchases of refractory clays for saggers, which have long been chiefly domestic, also declined more rapidly than sales of domestic kaolin and ball clays for pottery and stoneware. A sudden rise in the sales of domestic clay for high-grade tile, as reported for 1930 and 1931, reflects the operations of only one company, a fire-clay producer, and the product made from the clay was obviously of a different quality than the white-bodied tile to which the description "high-grade tile" was confined originally in the Bureau's reports. Figure 109 likewise brings out the slump in production of terra cotta and the close correlation between output of product and sales of domestic clay to the terra cotta industry.

In 1934 consumption of domestic glass-pot clays was 598 tons compared with 2,579 tons in 1933, 20,227 tons in 1932, and a maximum of 49,258 tons in 1929. The decline recently has been all out of proportion to the rate of activity of glass making, and although some of it is due to working off consumers' stocks there is a definite trend away from glass-pot melting in favor of tank melting of glass, and even in glassworks where pot melting is continued the pots show a much longer life, which again results in a decrease in the quantity of pot clay used to produce a given quantity of glass.

Clay sold by producers in the United States in 1934, by kinds and uses, in short tons

Use	Kaolin	Ball clay	Slip clay	Fire clay	Stoneware clay	Bentonite	Miscellaneous clay	Total
Pottery and stoneware:								
Whiteware, etc.	31,883	48,780		716				81,379
Chemical stoneware	317	453		670	3,020			4,460
Stoneware		226		4,200	20,331			24,757
Slip for glazing		1	318					319
	32,200	49,460	318	5,586	23,351			110,915
Tile, high-grade	6,520	6,599		12,137	848		206	26,310
Kiln furniture, etc.:								
Saggers	1,690	1,353		37,641				40,684
Pins, stilts, etc.				447				447
Wads				10,029				10,029
	1,690	1,353		48,117				51,160
Architectural terra cotta		1,768		5,367	2,524			9,659
Paper:								
Filler	218,425			50			300	218,775
Coating	31,077							31,077
	249,502			50			300	249,852
Rubber	48,259							48,259
Oilcloth and linoleum	5,227	2,130		1,704				9,061
Paints:								
Filler or extender	6,901	177					215	7,293
Kalsomine	4,576							4,576
	11,477	177					215	11,869
Cement manufacture	18,210	156		4,836		1,379		24,581
Refractories:								
Zinc retorts and condensers				20,399				20,399
Clay crucibles		324		363				687
Glass pots				598				598
Other glass refractories	616	115		9,421				10,152
Fire brick and block	17,041			664,322			3,187	684,550
Fire-clay mortar	10,186			161,365			904	172,455
Bauxite and high-alumina brick				9,416				9,416
Foundries and steel works	2,674			247,325		17,037	29,362	296,398
	30,517	439		1,113,209		17,037	33,453	1,194,655
Miscellaneous:								
Sewer pipe and drain tile	12,766			28,594	28,505		29,721	99,586
Building brick and tile (other than high-grade)				13,030			44,421	57,451
Flower pots				50	756		2,963	3,769
Rotary drilling mud						106,822	1,506	108,328
Filtering and decolorizing oils (activated earths)						82,396		82,396
Cosmetics						5		5
Water softening	18						105	123
Chemicals	1,412							1,412
Plaster and plaster products	2,668					25	550	3,243
Asbestos products	561			1,398				1,959
Artificial abrasives	40	141	3,101	319	498			4,099
Enameling		155		780				935
Crayons	230							230
Other (use not specified)	5,038	499	1,698	53,732	196	7,675	18,568	87,406
	22,733	795	4,799	97,903	29,955	196,923	97,834	450,942
Total, 1934	426,335	62,877	5,117	1,288,909	56,678	215,339	132,008	2,187,263
1933	411,233	64,551	1,562	1,133,693	28,188	117,428	83,518	1,840,173

TECHNOLOGIC DEVELOPMENTS

Electrophoresis combined with deairing is recommended by Chamberlin [2] to eliminate not only laminations but the cause of cleavage planes in extruded stoneware. By passing an electric current through the clay while it is being formed, sufficient electrolytes are pulled to the surface to act as a lubricant film. The die surfaces are held as cathodes, and an anode is placed behind them inside the forming machine.

Details of a steam-drying process, cheaper and yielding clay of better body and plasticity, have been described in England.[3]

Spalling has been investigated, and a modified formula for resistance to thermal shock has been worked out.[4]

Advantages are claimed for substituting clay for feldspar in enamel batches.[5]

The Northwest Experiment Station of the United States Bureau of Mines and the College of Mines, University of Washington, have been studying methods for beneficiating and using the nonmetallic resources of the Pacific Northwest since 1919. For over 20 years the white clays near Spokane, Wash., and Moscow and Troy, Idaho, have been manufactured into fire-clay and face-brick products by four companies. Articles produced with run-of-mine material were nearly white. Tests were made on the use of this material for paper, kalsomine, paint filler, pottery, electrical porcelain, and sanitary ware. Washing plants at Freeman and Aberdeen have operated for a short time, and a third company organized at Troy, Idaho, purifies and markets the kaolin. These kaolins range from highly plastic transported materials resembling ball clays to the weakly plastic residual clays. The former are more plastic than the Florida kaolin, and the latter lie between the Florida and the English in plastic properties. By proper mixing of these two types the use of imported clays for white pottery can be eliminated. These clays fire to dense, hard, vitrified bodies at comparatively low temperatures and show bluestoning tendencies, even though the purity is such that the P. C. E. value is near cone 34. The residual kaolins, on the other hand, are much whiter in the original and fired condition and retain their open structure to higher temperatures.[6]

Advantage was taken of P. W. A. and F. E. R. A. funds to carry on surveys of domestic resources of shales and clays under the supervision of the United States Geological Survey and with the cooperation of various State surveys. During 1934 the Missouri Geological Survey completed a rather extensive investigation of bleaching clays in southeastern Missouri, and samples of these clays will be tested for possible utilization in fired ware; further studies were made of flints and diaspore clays. Clay studies were an important part of the expanded activities of the Illinois State Survey, and reports of work on the geology of clays of Washington were issued; additional work and publications resulting from previous investigations are

[2] Chamberlin, J. M. W., Electrophoresis as Applied to Chemical Stoneware: Ind. and Eng. Chem. (news ed.), vol. 12, no. 16, Aug. 20, 1934, p. 303.

[3] Chemical Age (London), China-Clay Industry Development: Vol. 31, no. 799, 1934, p. 356.

[4] Preston, F. W., and White, H. E., Spalling of Clay: Jour. Am. Ceram. Soc., vol. 17, 1934, pp. 137–144.

[5] Vielhaber, Clay instead of Feldspar: Emailwaren-Ind., vol. 11, no. 33, 1934, pp. 273–275; Ceram. Abs., vol. 14, no. 1, January 1935, p. 4.

[6] Wilson, Hewitt, and Goodspeed, Geo. E., Kaolin and China Clay in the Pacific Northwest: Univ. of Washington, Eng. Exp. Sta. Bul. 76, 1934, 184 pp.

reported [7] in Alabama, Indiana, Iowa, Nevada, New Mexico, North Carolina, Ohio, Tennessee, and Texas. The State Geological Survey of Pennsylvania in 1934 published Bulletin 112 on the White Clays of Pennsylvania, by Henry Leighton, which probably will be followed by a report on fire clays and miscellaneous clays. The white clays are used chiefly as refractory or semirefractory cements and linings for converters and ladles in steel mills, for whitening portland cement, and in the washed state as a filler in the manufacture of paper. Other possible uses are in the manufacture of saggers, linoleum, rubber goods, kalsomine and other water paints, white tile, brick, and chinaware

CLASSIFICATION AND TESTING

Two Russian writers contributed to the discussion of a suitable classification for clay. Tomkeieff [8] attacked the problem from a statistical analysis of clay and bauxitic minerals, plotting the results of all available analyses on two preliminary diagrams and constructing frequency curves therefrom. The resulting classification, on a purely chemical basis (H_2O:Al_2O_3; SiO_2 ratio), falls into five groups, namely fuller's earth, pyrophyllite, "anauxite" (cimolite ($2Al_2O_3.9SiO_2.6H_2O$)), kaolinite, and bauxitic clay. The bentonitic minerals, not belonging strictly to the pure hydrous aluminum silicates, are placed in a separate group, as are micaceous halloysite, beidellite, montmorillonite, etc. The discussion disregards physical, optical, crystallographical, and structural features, but a State standard (OST 5539), introduced August 1, 1933, was described by Zubchaninov.[9] This classification is based upon (1) refractoriness (refractory, slow melting, easy melting), (2) presence of impurities, (3) alumina content in fired condition (high basic, basic, semiacid, acid), (4) grade of plasticity (binding, plastic, nonplastic, stonelike, shales), and (5) type of goods manufactured.

Farskii [10] has developed a novel method for investigating the firing properties of clay, employing small bars 1 by 2 by 25 cm long which are heated in a specially designed muffle so that one end of the bar is at fusing temperature while the other is at a predetermined firing temperature. Results so obtained show that, within the limits of 1160° and 1180° C., increase of linear shrinkage is almost proportional to temperature rise, becoming less, however, at higher temperatures, practically ceasing at 1200° C., and remaining practically constant to 1208° C., the fusing temperature. Under the test conditions a temperature gradient of only 100° C. could be obtained.

Methods of testing English china clays were described by Grant.[11]

In the United States the National Bureau of Standards has presented a theory on the colloidal nature of clays and related properties, based upon findings of certain soil chemists.[12]

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[7] American Ceramic Society, Report of Committee on Geological Surveys: Bull., vol. 14, no. 2, February 1935, pp. 75–77.

[8] Tomkeieff, S. I., Clay Minerals and Bauxitic Minerals. A Review and Classification Based on a Statistical Method: Mineralog. Mag., vol. 23, 1933, pp. 463–482.

[9] Zubchaninov, V., Classification of Clay Raw Materials: Ogneuporui, vol. 2, no. 9, 1934, pp. 18–22; Jour. Am. Ceram. Soc. Abs., vol. 6, no. 3, March 1935, p. 80.

[10] Farskii, V., A Method of Investigating Clay: Keramika i Steklo, 107 (1), 1934, pp. 37–38: Building Sci. Abs., vol. 7 (new ser.), no. 11, November 1934, pp. 380–381.

[11] Grant, Julius, Methods of Testing China Clay: Sands, Clays and Minerals, vol. 2, no. 11, August 1934, pp. 49–51.

[12] Meyer, W. W., Colloidal Nature and Related Properties of Clays: Nat. Bur. of Standards Jour. Research, vol. 13, no. 2, August 1934, pp. 245–258.

Ross and Kerr, of the United States Geological Survey, following up their pioneer investigations of the crystalline character of kaolin minerals,[13] have presented a new paper on halloysite and allophane.[14] Halloysite is closely related to but distinct from kaolinite and, like kaolinite, is always the result of weathering, whereas dickite and nacrite are commonly formed by hydrothermal action. Allophane is described as a common amorphous associate of halloysite. Montmorillonite [15] differs from pyrophyllite by swelling in water, the swelling being one dimensional.

Endell,[16] after presenting diagrams of 50 kaolins and clays from Germany, England, Czechoslovakia, and the United States, affirmed the different structure of montmorillonite and noted that, by changing the individual complex coating of kaolin and bentonite, the effect is far-reaching on plasticity, shrinkage on drying, and crushing strength.

THE INDUSTRY IN FOREIGN COUNTRIES

For many years the United Kingdom has been the principal source of clay for overseas trade. Germany and Czechoslovakia also have produced exportable surpluses, but the kaolin from these two countries has been shipped almost exclusively to nearby Europe, although a relatively small tonnage of glass-pot clays and allied specialty clays has been exported from Germany to the United States and other distant markets.

The active development of the china-clay mining industry in the United States, which received its first strong impetus during the World War, has resulted in sharp curtailment of imports and consequently increased independence of foreign supplies. The tendency to investigate local sources of clay and to encourage new clay-products manufacturing industries has become world-wide, as is indicated by the large number of geological and economic reports that have appeared during the last several years on clay resources of various countries. In the U. S. S. R. (Russia) the investigation of clay deposits is part of the general mineral program. In Canada studies of local clay deposits also have been a prominent activity for several years. Studies of a similar character seem to have been speeded up recently in many other countries, including not only undeveloped regions but also the highly industrialized nations of Europe. The following references accordingly are of interest with respect to the possible effects upon world trade as well as upon the individual countries concerned.

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[13] Ross, C. S., and Kerr, P. F. The Kaolin Minerals: U. S. Geol. Survey Prof. Paper 165–E, 1931, pp. 151–176.

[14] Ross, C. S., and Kerr, P. F., Halloysite and Allophane: U. S. Geol. Survey Prof. Paper 185–G, 1934–35, pp. 135–148.

[15] Hofmann, U., Endel, K., and Wilm, D., Crystal Structure and Swelling of Montmorillonite: Ztschr. Kristal., vol. 86, nos. 5 and 6, 1933, pp. 340–348.

[16] Endell, K., Nature of Kaolin and Clay in Ceramics: Presented at the Internat. Ceram. Cong., Milan, 1933, abstracted in Ceram. Abs., vol. 13, no. 6, June 1934, p. 159.

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ABRASIVE MATERIALS [1]

By A. E. Davis

SUMMARY OUTLINE

The value of abrasive materials sold in 1934 increased 20 percent compared with 1933, indicating that the recovery in the abrasives industries is still under way, despite decreases in output of some of the commodities.

Abrasive materials are important tools or agents employed in the manufacture of numerous products. Cutting, sawing, grinding, and polishing are essential processes in many manufacturing industries as diverse in character as are automobile manufacture and the finishing of memorial stones.

Abrasive materials play a prominent part in these processes; hence they are to a considerable extent indicators of industrial activity. The following table of salient statistics therefore presents not only the trend in activity of each commodity but portrays in some degree that of the industries in which abrasives are employed. The increase in sales of abrasives is due partly to their extensive use in the automobile and other industries that have had a comparatively rapid recovery and probably partly to their use in reconditioning equipment preparatory to enlarged production schedules. Information on preparation of abrasives, by Tyler, was published recently.[2]

Some commodities included in this chapter also have important nonabrasive uses. For instance, only relatively small quantities of diatomite and tripoli are now used as abrasives compared with the quantities formerly so used. It seems desirable, however, to continue to include such commodities in the annual chapters of this series for purposes of comparison until the minerals in this diverse group are reclassified.

[1] Figures on production compiled by A. E. Davis, A. T. Coons, and M. Allan, of the Bureau of Mines. Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

[2] Tyler, Paul M., Mechanical Preparation of Nonmetallic Minerals: Trans. Am. Inst. Min. and Met. Eng., Milling Vol. no. 112, 1934, pp. 787–789.

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Salient statistics of abrasive industries in the United States, 1933–34

	1933	1934	Percent of change in 1934
Domestic production:			
Natural siliceous abrasives:			
Diatomite	[1] $1,300,709	[1] $1,300,709	
Tripoli (value as sold—crude and finished)[2]	350,383	329,356	−6.0
Pumice and pumicite	241,834	207,058	−14.4
Quartz	71,048	129,965	+82.9
Ground sand and sandstone	1,106,410	1,392,173	+25.8
Special stone products:			
Grindstones and pulpstones	444,250	463,234	+4.3
Oilstones and related products	96,597	94,419	−2.3
Millstones	8,387	10,101	+20.4
Flint lining and grinding pebbles	47,011	(3)	
Garnet and emery:			
Garnet	224,717	214,815	−4.4
Emery	12,283	1,800	−85.3
Total natural abrasives	3,903,629	[4] 4,143,630	+6.1
Total artificial abrasives	4,534,265	5,972,697	+31.7
Grand total	8,437,894	[4] 10,116,327	+19.9
Foreign trade:			
Imports	1,687,831	3,405,881	+101.8
Exports	460,849	510,875	+10.9

[1] Average for 1930–32, inclusive; annual data for those years and for 1933 and 1934 not available for publication.
[2] No sales of crude reported in 1934.
[3] Bureau of Mines not at liberty to publish figures.
[4] Exclusive of value of flint lining and grinding pebbles.

The history of production of each major branch of the abrasive industries from 1912 to 1934 is shown graphically in figure 110.

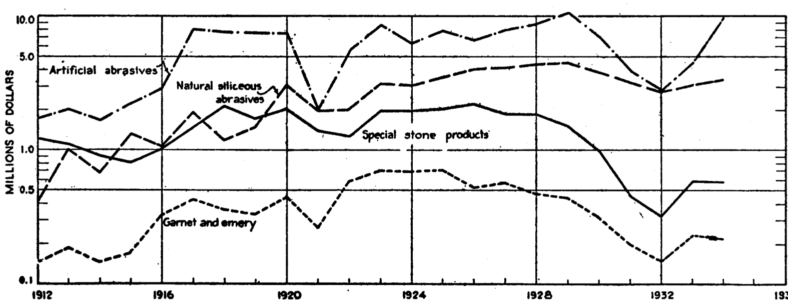

FIGURE 110.—Annual values of production of major abrasives groups, 1912–34. Artificial abrasives include silicon carbide, synthetic aluminum oxide, and various metallic abrasives, such as crushed steel, steel shot, and steel wool. Natural siliceous abrasives include pulverized quartz, sand and sandstone, diatomite, tripoli, and pumice and pumicite; in this group, figures for diatomite are partly incomplete for 1915–18, and the 3-year averages used since 1927 tend to stabilize somewhat the composite curve over recent years. Grinding and polishing sand (unpulverized) is not included; statistics appear in the chapter on Sand and Gravel. Special stone products include grindstones, pulpstones, millstones, oilstones and related quarry products, and grinding pebbles and flint lining for tube mills.

NATURAL SILICEOUS ABRASIVES

Diatomite.—The Bureau of Mines is not at liberty to publish annual production figures for diatomite, but permission has been obtained to show production for 3-year periods. Such data for 1927–32 are given in the following table. Figures for 1933 and 1934 may not be published, but both years showed increases in sales compared with the preceding year.

Diatomite sold or used by producers in the United States, 1927–34 [1]

Year	Short tons	Value	Year	Short tons	Value
1927 } 1928 } 1929 }	286,426	$4,164,721	1930 } 1931 } 1932 }	248,273	$3,902,126
			1933	(1)	(1)
			1934	(1)	(1)

[1] Bureau of Mines not at liberty to publish annual figures.

A brief description of the composition and uses of diatomite is given in Minerals Yearbook, 1934, page 891.

The principal centers of production are in the Western States, notably near Lompoc, Calif., where large deposits of high-grade material have been worked for many years. Increased production and sales of diatomite from deposits near Walteria in Los Angeles County, Calif., have also been made in recent years. In 1934 diatomite was produced also in other parts of California and in Oregon, Washington, Arizona, Nevada, New York, and New Jersey, listed in the order of their output.

The majority of the producers reported higher selling prices for their material in 1934 than in 1933, but a few reported lower prices.

The Raylite Aggregates, Inc., 1106 Detwiler Building, Los Angeles, Calif., which has been experimenting for the past 2 years with an impure diatomite to produce a light-weight aggregate for concrete, reported leasing a plant in October 1934 at 2800 Pacific Avenue, San Pedro, but production did not begin until 1935. The company also reported an order to deliver material to the Bell High School, Los Angeles. Raw material is procured in San Pedro, but a deposit in the Palos Verdes Hills near Lomita may be developed.

The Dulassen Diatom Products Co., Ltd., 343 Chamber of Commerce Building, Los Angeles, Calif., successor to the Solvang Development Co., expected to start operation of its mine at Solvang, Santa Barbara County, Calif., by February 1, 1935. In January the plant was reported as completed except for the installation of electric motors and some of the small machinery.

Langlois Bros., 717 South San Pedro Street, Los Angeles, Calif., successor to the United States Diatom Co., reported that they expected to begin work at their deposit in Esmeralda County, Nev., near Basalt, in June 1935.

The Mammoth Diatomaceous Earth Co. and the Haymon Krupp Products Corporation reported output from Arizona for the first time; the former stated that its material was used principally by the building trades in Tucson, Ariz., and the latter sold its material for use in cleaning compounds. J. G. Marcrum, a new producer from New Jersey, reported that his material was used for insulation, polishing, and cement.

The Dicalite Co. reported steadily increasing shipments of diatomite from extensive deposits near Walteria, Calif.

In recent years some interest has been renewed in the diatomite deposits in the eastern part of the country and brief notes concerning deposits in New York, Maryland, Virginia, and Florida were published in Minerals Yearbook, 1934, page 891.

The companies reporting production and sales of diatomite in the United States in 1934, with locations of the deposits from which it was obtained, were as follows:

Atomite Products Co., 803 American Bank Building, Portland, Oreg. Deposit at Terrebonne, Deschutes County, Oreg.

The Dicalite Co., 756 South Broadway, Los Angeles, Calif. Deposit at Walteria, Los Angeles County, Calif.

The Electro-Silicon Co., 22 Cliff Street, New York, N. Y. Deposit at Virginia City, Storey County, Nev.

Haymon Krupp Products Corporation, El Paso, Tex. Deposit near Duncan, Greenlee County, Ariz.

Johns-Manville Products Corporation, 22 East Fortieth Street, New York, N. Y. Deposit at Lompoc, Santa Barbara County, Calif.

Kittitas Diatomite Co., Ellensburg, Wash. Deposit at Kittitas, Kittitas County, Wash.

Mammoth Diatomaceous Earth Co., Lordsburg, N. Mex. Deposit at Mammoth, Pinal County, Ariz.

Marcrum, J. G., Netcong, N. J. Deposit near Stanhope, Sussex County, N. J.

Mineral Products Co., 1735 Chelsea Road, San Marino, Calif. Deposit at Walteria, Los Angeles County, Calif. (Successor to Floatstone Products Co.)

Mineral Products Manufacturing Co., 1735 Ventura Avenue, Fresno, Calif. Deposit at Mendota, Fresno County, Calif.

National Diato Co. Deposit and office at Harper, Malheur County, Oreg. (Successor to Pacific Coast Diatom Co.)

National Silica Products Co., 1201 Bryant Street, Palo Alto, Calif. Deposit at Lompoc, Santa Barbara County, Calif.

Pacatome, Inc., Bradley, Calif. Deposit near Bradley, Monterey County, Calif.

The Paraffine Companies, Inc., 475 Brannan Street, San Francisco, Calif. Deposit near Lompoc, Santa Barbara County, Calif.

Tri-O-Lite Products Co. Deposit and office at Carlin, Elko County, Nev.

Webley, E. J. Deposit and office at Quincy, Grant County, Wash.

Wright, John P., Keene, N. H. Deposit at Wilmurt, Herkimer County, N. Y.

Tripoli.—The output of tripoli and related materials in 1934 was 20,529 short tons valued at $329,356, a decrease of 2 percent in quantity and 6 percent in value compared with 1933.

Information on uses of tripoli, types of material produced, and location of deposits from which commercial material is obtained, was published in Minerals Yearbook, 1934, page 892.

In 1933 the Bureau of Mines presented for the first time statistics on the quantity and value of tripoli sold by producers according to uses. Efforts to obtain similar data for 1934 resulted in the addition of one name to those who reported for 1933. The figures are incomplete, as some producers kept no record of the uses for which their material was sold and others sold their material largely through jobbers and therefore had no way of determining the different uses.

Sales according to uses reported by nine producers totaled 16,258 short tons valued at $251,778, or 79 percent of the quantity and 76 percent of the value of total sales reported. Distribution of sales by uses is shown in the following table.

Tripoli sold or used by producers in the United States in 1934, by uses

Use	Number of producers reporting	Short tons	Value as sold (finished)	Percent of total accounted for	
				Quantity	Value
Abrasives	7	8,516	$135,678	52.4	53.9
Concrete admixture	3	582	9,973	3.6	4.0
Filler	5	2,224	34,872	13.7	13.8
Foundry facing	5	2,477	38,231	15.2	15.2
Miscellaneous	5	2,459	33,024	15.1	13.1
Total accounted for	[1] 9	16,258	251,778	100.0	100.0
Use not specified	2	4,271	77,578		
Grand total	11	20,529	329,356		

[1] A producer reporting more than 1 use is counted only once in arriving at total.

As less than three producers reported material for filter block, the Bureau of Mines is not at liberty to publish the figures; the sales are included with those for miscellaneous uses. Material sold for pottery and as "drilling-mud weighting material" in oil wells is also included in this classification. Some producers did not specify the miscellaneous uses.

The following table gives production data for tripoli from 1930 to 1934.

Tripoli (including Pennsylvania rottenstone) sold or used by producers in the United States, 1930–34

Year	Illinois			Other States [1]			Total		
	Short tons	Value		Short tons	Value		Short tons	Value	
		Crude (partly estimated)	As sold (crude and finished)		Crude (partly estimated)	As sold (crude and finished)		Crude (partly estimated)	As sold (crude and finished)
1930	9,954	$22,813	$116,307	22,485	$48,977	$391,198	32,439	$71,790	$507,505
1931	12,651	27,170	87,481	14,031	29,078	222,650	26,682	56,248	310,131
1932	6,097	10,895	84,795	8,678	20,527	147,905	14,775	31,422	232,700
1933	8,757	18,103	149,979	12,121	27,582	200,404	20,878	45,685	350,383
1934 [2]	7,417	17,241	119,418	13,112	27,622	209,938	20,529	44,863	329,356

[1] 1930: Arkansas, Georgia, Missouri, Oklahoma, Pennsylvania, and Tennessee; 1931–32: Arkansas, Missouri, Oklahoma, Pennsylvania, and Tennessee; 1933–34: Arkansas, California, Georgia, Missouri, Oklahoma, Pennsylvania, and Tennessee.
[2] No sales of crude reported in 1934.

The majority of the tripoli producers reported lower selling prices for their products in 1934 than in 1933.

The companies reporting production and sales of tripoli (including Pennsylvania rottenstone) in the United States in 1934, with locations of the deposits from which the material was obtained, were as follows:

Barnsdall Tripoli Co., Seneca, Mo. Deposits at Seneca, Newton County, Mo., and in Ottawa County, Okla., near Seneca, Mo.

Central Silica Corporation, Comer Building, Birmingham, Ala. Deposit near Collinwood, Wayne County, Tenn.

Corona Silica, Inc. Deposit and office at Rogers, Benton County, Ark.

Friend, D. N., and Wheeler, H. R., Joplin, Mo. Deposit near Peoria, Ottawa County, Okla.

Independent Gravel Co., 220½ West Fourth Street, Joplin, Mo. Deposit at Racine, Newton County, Mo.

Geo. S. Mepham Corporation, East St. Louis, Ill. Deposit at Delta Alexander County, Ill.

Olive Branch Minerals Co. Deposit and office at Olive Branch, Alexander County, Ill.

Ozark Minerals Co., 807½ Washington Avenue, Cairo, Ill. (lessees of property of the Illinois Minerals Co.). Deposit at Elco, Alexander County, Ill.

Penn Paint & Filler Co. Deposit and office at Antes Fort, Lycoming County, Pa.

Tennessee Valley Mineral Co. (William J. Seas), route 3, Summerville, Ga. Deposit near Summerville, Chattooga County, Ga.

Western Talc Co., 1901 East Slauson Street, Los Angeles, Calif. Deposit near Barstow, San Bernardino County, Calif.

Pumice and pumicite.—Sales of pumice and pumicite in 1934 decreased 8 percent in quantity and 14 percent in value from 1933. The majority of the producers reported lower selling prices for their products in 1934 than in 1933. The following table shows the quantity and value of pumice and pumicite sold or used by producers for the past 5 years.

Pumice and pumicite sold or used by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	56,843	$336,099	1933	61,220	$241,834
1931	68,819	338,586	1934	56,169	207,058
1932	53,214	235,204			

Some information on uses and physical characteristics of pumice and pumicite was included in Minerals Yearbook, 1934, page 894.

The following table shows sales according to uses. Approximately 89 percent of the material was used for cleansing and scouring compounds and hand soaps. A decrease was reported in sales for concrete admixture and concrete aggregate, but an increase in sales for acoustic plaster; 5 producers reported sales for acoustic plaster in 1934 compared with only 2 in 1933.

Pumice and pumicite sold or used by producers in the United States, 1933–34, by uses

Use	1933			1934		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Cleansing and scouring compounds and hand soaps	47,689	$171,490	$3.60	49,719	$162,832	$3.28
Other abrasive uses	(1)	(1)	(1)	299	3,302	11.04
Concrete admixture and concrete aggregate	6,926	19,897	2.87	601	3,426	5.70
Acoustic plaster	(1)	(1)	(1)	1,581	19,181	12.13
Miscellaneous uses [2]	6,605	50,447	7.64	3,969	18,317	4.62
	61,220	241,834	3.95	56,169	207,058	3.69

[1] Included under "Miscellaneous uses."

[2] 1933: Includes material used as insecticide, floor sweep, and heat or cold insulation, in linoleum manufacture, for filtering, as dental material, and in asphalt, acoustic plaster, and unspecified abrasive uses; 1934: Includes material used as insecticide, floor sweep, and heat or cold insulation, for filtering, in asphalt, and for grading roads, chicken litter, and some unspecified uses.

The companies reporting production and sales of pumice and pumicite in the United States in 1934, with locations of the deposits from which the materials were obtained, were as follows:

Bennett & Jourdan, Selma, Calif. Deposit in Madera County near Friant (Fresno County), Calif.

Brown, Charles. Deposit and office at Shoshone, Inyo County, Calif.

California Quarries Corporation, 1300 Quinby Building, Los Angeles, Calif. Deposit in Mono County near Laws, Calif.

Chamberlain Co., 2550 East Ninth Street, Los Angeles, Calif. Deposit near Calipatria, Imperial County, Calif.

The Cudahy Packing Co., 221 North LaSalle Street, Chicago, Ill. Deposits at Fowler, Meade County, Kans., and at Saltdale, Kern County, Calif.

The Davidson Pumice Co., Norton, Kans. Deposits at Calvert, Norton County, Meade, Meade County, and Natoma, Osborne County, Kans.

Dodson Concrete Board Co., 1463 Barwise Avenue, Wichita, Kans. Deposit at Wilson, Ellsworth County, Kans.

Gray Eagle Placer Mining Claim (M. L. Francis), R. F. D., Creston, Calif. Deposit near Creston, San Luis Obispo County, Calif.

Johnson, G. Z., 255 California Street, San Francisco, Calif. Deposit at Pumice Mountain, near Macdoel, Siskiyou County, Calif.

Kalite Co., Ltd., 90 South Oak Knoll Avenue, Pasadena, Calif. Deposit near Calipatria, Imperial County, Calif.

La Ritchie, Claire E. (West Coast Pumice Co.), P. O. Box 281, Klamath Falls, Oreg. Deposit near Chemult, Klamath County, Oreg.

La Rue Axtell Pumice Co., Eustis, Nebr. Deposits at Eustis, Frontier County, and Ingham, Lincoln County, Nebr.

Mid-Co Products Co., 239 Railway Exchange Building, Kansas City, Mo. Deposits at Meade, Meade County, and in Grant County near Satanta (Haskell County), Kans., and near Gate, Beaver County, Okla.

Pearl Pumice Quarries (successor to Pumice Products Co.), Box 565, Monticello Way, Napa, Calif. Deposit near Napa, Napa County, Calif.

Pumicite Co., 4025 Clara Avenue, St. Louis, Mo. Deposit at Fowler, Meade County, Kans.

Tonopah & Tidewater Railway, 510 West Sixth Street, Los Angeles, Calif. Deposit at Shoshone, Inyo County, Calif.

Victorville Lime Rock Co., 2149 Bay Street, Los Angeles, Calif. Deposit at Sykes, Inyo County, Calif.

Zimmerman, H. H., Belle Plaine, Kans. Deposit in Grant County near Satanta (Haskell County), Kans. (Leased to Mid-Co Products Co., June 6, 1934).

Quartz.—The production of quartz in the United States in 1934 from pegmatite dikes or veins or from quartzite amounted to 18,293 short tons valued at $129,965, an increase of 64 percent in tonnage and 83 percent in value compared with 1933. About 24 percent of the total was sold as crude or crushed quartz and about 76 percent as ground quartz. Part of the crude also may have reached ultimate consumers as ground quartz.

A brief statement on uses of quartz was given in the corresponding chapter of Minerals Yearbook, 1934, page 896.

Production data from 1930 to 1934 are shown in the following tables.

Quartz sold or used by producers in the United States, 1930–34

Year	Crude [1]		Ground [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1930	7,362	$32,531	5,794	$88,758	13,156	$121,289
1931	4,460	19,208	[3] 3,391	[3] 49,895	[3] 7,851	[3] 69,103
1932	4,383	15,394	[3] 3,104	[3] 43,764	[3] 7,487	[3] 59,158
1933	4,094	14,556	[3] 7,059	[3] 56,492	[3] 11,153	[3] 71,048
1934	4,447	16,168	13,846	113,797	18,293	129,965

[1] Includes some crushed quartz.
[2] To avoid duplication, the ground material shown here is only that ground by the original producers of the crude quartz or by grinders who purchase from small miners not reporting their production.
[3] Partly estimated.

Quartz (crude, crushed, and ground [1]) sold or used by producers in the United States, 1932–34, by States

State	1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value
California	253	$4,897	(2)	(2)	(2)	(2)
Maryland	347	5,200	371	$5,565	564	$6,390
Massachusetts	373	2,170				
North Carolina	1,535	7,045	(2)	(2)	(2)	(2)
Undistributed [3]	[4] 4,979	[4] 39,846	[4] 10,782	[4] 65,483	17,729	123,575
	[4] 7,487	[4] 59,158	[4] 11,153	[4] 71,048	18,293	129,965

[1] To avoid duplication, the ground material included is only that ground by the original producers of the crude quartz or by grinders who purchase from small miners not reporting their production.
[2] Included under "Undistributed."
[3] 1932: Arizona, New York, Ohio, and Wisconsin; 1933: Arizona, California, Missouri, New Jersey, New York, North Carolina, Ohio, Tennessee, and Wisconsin; 1934: Arizona, California, Missouri, New Jersey, New York, North Carolina, Ohio, Tennessee, and Virginia.
[4] Partly estimated.

Following is a list of some recent producers and sellers of crude quartz:

Carolina Minerals Co., Inc., Spruce Pine, N. C.
Consolidated Feldspar Corporation, Trenton, N. J.
Day Quartz Co., Sykesville, Md.
Kingman Feldspar Co., Kingman, Ariz.

Following is a list of producers of "crushed" quartz:

Consolidated Feldspar Corporation, Trenton, N. J.
Ohio Quartz Products Corporation, Jackson, Ohio.
Spicky Polish Corporation, 1401 Third Street, San Francisco, Calif.

Following is a list of manufacturers of ground quartz:

Charlotte Chemical Laboratories, Inc., Charlotte, N. C.
Consolidated Feldspar Corporation, Trenton, N. J.
Eureka Flint & Spar Co., Trenton, N. J.
Glading, McBean & Co., Los Angeles, Calif.
Harford Talc & Quartz Co., P. O. Box 63, Towson, Md.
Pioneer Silica Products Co., Pacific, Mo.
Shenandoah Silica Co., P. O. Box 266, Trenton, N. J.
Tennessee Mineral Products Corporation, Spruce Pine, N. C.

Ground sand and sandstone.—Production of ground sand and sandstone increased from 202,099 short tons valued at $1,106,410 in 1933 to 248,026 tons valued at $1,392,173 in 1934, or 23 percent in tonnage and 26 percent in value. These figures include material known in some localities as "silica flour."

Appreciable quantities of ground sand and sandstone are sold by companies producing glass sand and other special silica sands. This pulverized silica is used widely in the ceramic trades; as a silica wash for molds in steel-foundry work; as a filler in prepared roofing, paint, and like products; in fertilizers; and as an abrasive agent in various cleaning and scouring compounds.

The following tables give production data from 1930 to 1934.

Ground sand and sandstone sold or used by producers in the United States, 1930–34 [1]

Year	Short tons	Value	Year	Short tons	Value
1930	241,947	$1,566,815	1933	202,099	$1,106,410
1931	183,880	1,196,425	1934	248,026	1,392,173
1932	150,109	875,749			

[1] Includes only finely ground material. Figures probably incomplete.

Ground sand and sandstone sold or used by producers in the United States, 1933–34, by States [1]

State	1933		1934	
	Short tons	Value	Short tons	Value
Illinois	52,230	$273,526	50,748	$285,849
Massachusetts	343	2,509	514	3,471
New Jersey	67,080	270,346	64,467	291,733
Ohio and Pennsylvania	65,308	418,933	59,128	368,720
Virginia }	13,456	105,021	-------	-------
West Virginia }			(2)	(2)
Undistributed [3]	3,682	36,075	73,169	442,400
	202,099	1,106,410	248,026	1,392,173

[1] Includes only finely ground material. Figures probably incomplete.
[2] Included under "Undistributed."
[3] 1933: California, Delaware, and Wisconsin; 1934: California, West Virginia, and Wisconsin.

The following companies reported production of ground sand and sandstone in 1933 and 1934:

Central Silica Co., Zanesville, Ohio.
Cheshire White Quartz Sand Co., Cheshire, Mass.
Del Monte Properties Co., 401 Crocker Building, San Francisco, Calif.
Michigan Quartz Silica Co., Milwaukee, Wis.
Minnesota Mining & Manufacturing Co., St. Paul, Minn.
National Pulverizing Co., Millville, N. J.
National Silica Co., Oregon, Ill.
National Silica Works, Berkeley Springs, W. Va.
New Jersey Pulverizing Co., 205 West Thirty-fourth Street, New York, N. Y.
Ottawa Silica Co., Box 506, Ottawa, Ill.
Pennsylvania Glass Sand Corporation (grinds in New Jersey, Pennsylvania, and West Virginia), Lewistown, Pa.
Potters Mining & Milling Co., East Liverpool, Ohio.
Standard Flint & Spar Corporation, Trenton, N. J.
Standard Sanitary Manufacturing Co., Campo, Calif.
Standard Silica Co., 400 West Madison Street, Chicago, Ill.
Wedron Silica Co., 38 South Dearborn Street, Chicago, Ill.
White Rock Silica Co., 21 North Curtis Street, Chicago, Ill.

SPECIAL STONE PRODUCTS

Grindstones and pulpstones.—There was a decrease of 13 percent in quantity and 4 percent in value of natural grindstones sold in 1934. Pulpstones decreased 4 percent in quantity but increased 22 percent in value in 1934. Grindstones and pulpstones are produced chiefly in Ohio and West Virginia; smaller quantities come from Washington. The following table shows sales from 1930 to 1934.

Grindstones and pulpstones sold by producers in the United States, 1930–34

Year	Grindstones		Pulpstones		
	Short tons	Value	Pieces	Short tons	Value
1930	14,559	$423,835	1,176	4,141	$346,736
1931	6,994	221,272	482	1,730	120,877
1932	6,001	158,566	483	1,667	88,874
1933	11,197	298,174	855	2,979	146,076
1934	9,781	285,603	760	2,849	177,631

The companies reporting production of grindstones and pulpstones for commercial purposes in the United States in 1934, with locations of the quarries from which the stone was obtained, are as follows:

Briar Hill Stone Co. (grindstones). Quarry and office at Glenmont, Holmes County, Ohio.

Cleveland Quarries Co., Cleveland, Ohio (grindstones). Quarries at Amherst, Lorain County, Ohio; at Berea, Cuyahoga County, Ohio; and at Marietta, Washington County, Ohio.

Constitution Stone Co., Constitution, Ohio (grindstones and pulpstones). Quarries at Constitution, Washington County, Ohio; at Ravenswood, Jackson County, W. Va.; and at St. Marys, Pleasants County, W. Va.

General Stone Co., Amherst, Ohio (pulpstones). Quarry at Opekiska, Monongalia County, W. Va.

Hall Grindstone Co. (grindstones). Quarry and office at Marietta, Washington County, Ohio.

The International Pulpstone Co., Elyria, Ohio. Quarries in Jefferson and Columbiana Counties, Ohio (idle in 1934), and in Boone County, W. Va.

Mount Pisbia Stone Co., Elyria, Ohio (grindstones). Quarry at Layland, Coshocton County, Ohio.

Nicholl Stone Co., Lorain, Ohio (grindstones). Quarry at Kipton, Lorain County, Ohio.

Ohio Valley Stone Co. (grindstones). Quarry and office at Marietta, Washington County, Ohio.

Scheel Eversharp Pulp Burr Co., Sedro Woolley, Wash. Quarry at Rockport, Skagit County, Wash.

Smallwood-Low Stone Co., Fairmont, W. Va. (pulpstones). Quarry in Monongalia County near Fairmont, W. Va.

Smallwood Stone Co., Union Trust Building, Cleveland Ohio (pulpstones). Quarries at Empire, Jefferson County, Ohio (idle in 1934), and at Opekiska, Monongalia County, W. Va.

Uffington Stone Co. (pulpstones). Quarry and office at Uffington, Monongalia County, W. Va.

Walker Cut Stone Co., Tacoma, Wash. (pulpstones). Quarry at Wilkeson, Pierce County, Wash.

West Virginia Pulpstone Corporation, Builders Exchange Building, Cleveland, Ohio (pulpstones). Quarry at Morgantown, Monongalia County, W. Va.

Oilstones and related products.—The small natural abrasive stones included in this group have highly diversified uses. Although artificial abrasives compete with them in virtually every application the natural stones have qualities that encourage their continued use. There was a decrease of 33 percent in quantity and 2 percent in value in 1934 compared with 1933.

Oilstones are manufactured from novaculite quarried in Arkansas; scythestones and whetstones are made chiefly of sandstone from Ohio and Indiana and of schist from Vermont; and rubbing stones are fine-grained sandstones quarried in Indiana and Ohio. The following table shows production for the past 5 years.

Oilstones and other whetstones, hones, scythestones, and rubbing stones sold by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	651	$137,184	1933	587	$96,597
1931	370	81,951	1934	396	94,419
1932	331	63,960			

The manufacturers of oilstones and other whetstones, scythestones, and rubbing stones from natural stone in 1934, with the sources of their raw materials, are as follows:

American Rubbing Stone Co., Cincinnati, Ohio (rubbing stones). Quarry at Floyds Knobs, Floyd County, Ind.

Bracher Agate & Abrasive Co., Summit, N. J. (oilstones and whetstones). (Has no quarries. Manufactures stone purchased in various localities.)

Chaillaux, J. A. Quarries at West Baden, Ind. (Sells this stone to Norton Pike Co. Buys Arkansas and Ohio stone and manufactures it.)

Cleveland Quarries Co., Cleveland, Ohio (scythestones, lathe stones, and holystones). Quarries at Amherst, Lorain County, Ohio, and at Berea, Cuyahoga County, Ohio.

Garland Whetstone & Kaolin Co., Hot Springs, Ark. (Produces rough stone, in Garland County, for oilstones, some of which is shipped abroad, and some of which is sold to manufacturers in this country.)

Lewis Whetstone Co., W. E. Lewis, Hot Springs, Ark. (Produces rough stone, in Garland County, for oilstones, most of which is shipped to Germany.)

Norton Pike Co., Littleton, N. H. (oilstones, whetstones, and scythestones). Production from Barton, Orleans County, Vt.; Hot Springs, Garland County, Ark.; McDermott, Scioto County, Ohio; and West Baden, Orange County, Ind. (Quarries owned are in Arkansas and Vermont. Stone from Ohio and Indiana is purchased.)

Millstones.—Sales of millstones and related products of domestic origin in 1934 increased 20 percent in value compared with 1933.

Some information on use of millstones in industry and types of stone produced was included in Minerals Yearbook, 1934, page 900.

The following table presents production data for millstones and related products from 1930 to 1934.

Value of millstones, chasers, and dragstones sold by producers in the United States, 1930–34

Year	New York		Other States [1]		Total	
	Producers	Value	Producers	Value	Producers	Value
1930	7	$6,577	5	$11,125	12	$17,702
1931	6	2,030	2	3,300	8	5,330
1932	5	1,850	2	2,600	7	4,450
1933	7	5,187	2	3,200	9	8,387
1934	5	3,381	3	6,720	8	10,101

[1] 1930: New Hampshire, North Carolina, and Virginia; 1931–34: North Carolina and Virginia.

The following are names and addresses of the producers who reported sales of millstones and chasers of their own manufacture in the United States in 1934; the raw material from which the stones were made was obtained from Ulster County, N. Y.; Rowan County, N. C.; and Montgomery County, Va.

Coddington, George, Accord, N. Y.
Coddington, Oscar, Accord, N. Y.
Decker, Floyd, Kerhonkson, N. Y.
Esopus Millstone Co., High Falls, N. Y.
Gardner Bros., Salisbury, N. C.
Laurence, Harry, Accord, N. Y.
Shealor, J. Fred, Route 2, Blacksburg, Va.
Snider, R. E., Cambria, Va.

Flint lining and grinding pebbles.—The Bureau of Mines is not at liberty to publish figures on production of grinding pebbles and tube-mill lining in 1934 as output was reported by only two producers. Sales of flint beach pebbles from the ocean front in San Diego County, Calif., were reported by John T. Momand, Pacific Coast Pebble Co., Carlsbad, Calif., and sales of cut cubes and tube-mill liners of quartzite quarried near Jasper, Minn., were reported by Jasper Stone Co., Sioux City, Iowa. The marked increase in demand for these materials in 1933 was followed by a decrease in 1934. Although steel balls are used extensively for grinding, a continued moderate demand for flint pebbles is to be expected because some industries require a product with a minimum iron content. For instance, nearly all raw materials for the pottery industry are ground with flint pebbles in flint-lined mills.

It was reported to the Bureau of Mines that the name and equipment of the Jasper Products Co., formerly of Jasper, Minn., had been purchased by the Jasper Stone Co. in 1934.

The following table gives figures of production for 1930–33.

Pebbles for grinding and flint lining for tube mills sold or used by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	3,480	$50,816	1933	3,709	$47,011
1931	2,024	26,211	1934	(1)	(1)
1932	976	13,070			

[1] Bureau of Mines not at liberty to publish figures.

GARNET AND EMERY

Garnet.—Sales of garnet in 1934 decreased 7 percent in quantity and 4 percent in value compared with 1933, following the substantial increases in 1933 of 43 percent in quantity and 53 percent in value over 1932.

A large part of all the garnet sold is used in the manufacture of abrasive paper and cloth. For this use it has resisted the competition of artificial abrasives comparatively well. Small quantities are employed for grinding plate glass and other products.

The following table shows production of abrasive garnet for the past 5 years.

Abrasive garnet sold or used by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	5,003	$314,129	1933	2,794	$224,717
1931	2,946	193,015	1934	2,591	214,815
1932	1,950	147,350			

The companies reporting sales of garnet in the United States in 1934, with locations of the deposits from which the garnet was obtained, are as follows:

Barton Mines Corporation. Deposit and office at North Creek, Warren County, N. Y.

Garnet Products Co. Deposit and office at South Danbury, Merrimack County, N. H.

Warren County Garnet Mills, 149 Orange Street, Newark, N. J. Deposit near Riparius (Johnsburg), Warren County, N. Y.

Emery (including corundum).—Emery, a mixture of corundum and magnetite, used principally as a grinding agent in the metal trades, has been replaced extensively by artificial abrasives. In recent years production has been confined to the Peekskill district of New York. Sales of emery in 1934 were reported by only one company: Smith & Ellis, Peekskill, N. Y.; deposit near Peekskill, Westchester County, N. Y. The Keystone Emery Mills, 4329 Paul Street, Frankford, Philadelphia, Pa. (deposit near Peekskill, Westchester County, N. Y.), reported that due to depressed conditions throughout the country their mines were not operated in 1934 but that operations will be resumed when business improves.

The mineral corundum, a natural aluminum oxide surpassed in hardness only by diamond, has not been mined in the United States since 1918 insofar as Government records show. As a small tonnage of imported corundum, chiefly from South Africa, is used each year, there has been some interest in the development of domestic deposits. Such an enterprise must face competition from artificial abrasives.

The following table gives production of domestic emery for the past 5 years.

Emery sold or used by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	555	$5,996	1933	1,056	$12,283
1931	512	5,557	1934	189	1,800
1932	250	2,781			

ARTIFICIAL ABRASIVES

Artificial abrasives may be divided into three main groups: (1) Metallic abrasives, such as crushed steel, steel shot, and steel wool; (2) metallic carbides, chiefly silicon carbide; and (3) synthetic aluminum oxide.

The combined production of silicon carbide and aluminum oxide increased 36 percent in quantity and 30 percent in value in 1934 compared with 1933. As these abrasives are used primarily in the metal trades, the larger sales doubtless resulted from increased activity in the iron, steel, and allied industries. Metallic abrasives also increased in 1934 (51 percent in quantity and 45 percent in value over 1933) following decreases for 4 successive years.

The production of a new abrasive,[3] "Norbide", the hardest material ever made by man (almost as hard as the diamond) was announced by Raymond R. Ridgway of the Research Laboratories of Norton Co., Worcester, Mass., before the Electrochemical Society at Hotel Pennsylvania, New York City, September 27, 1934. This new material, chemically known as "boron carbide", is a combination of the rare metal boron and ordinary carbon, such as coke. According to the article, "Boron carbide is so hard that it readily scratches and cuts the hardest of known synthetic materials which have previously existed."

The table that follows gives the production of silicon carbide, aluminum oxide, and steel shot or crushed steel grains. These materials compete with the natural abrasives used as grains—for example, emery, corundum, and garnet. The figures represent the total output of crude materials or first products of the manufacturing plants, not all of which are used as abrasive materials. A large but undetermined part of the silicon carbide and aluminum oxide output is used for refractory and other purposes not within the abrasive field. The total output is shown here without separation of the products according to uses, because it is thought that the proportion used as abrasive material has not fluctuated so widely in recent years as to destroy the value of these figures for comparison with the statistics of natural abrasives.

Crude artificial abrasives sold, shipped, or used, from manufacturing plants in the United States and Canada, 1930–34

Year	Silicon carbide		Aluminum oxide		Metallic abrasives		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	22,008	$2,047,188	46,465	$4,067,148	16,428	$977,037	84,901	$7,091,373
1931	8,193	967,840	25,070	2,336,586	11,105	613,683	44,368	3,918,109
1932	11,593	1,066,064	18,835	1,400,420	8,482	410,264	38,910	2,876,748
1933	16,606	1,715,989	30,778	2,436,962	6,844	381,314	54,228	4,534,265
1934	18,038	1,753,019	46,496	3,665,226	10,312	554,452	74,846	5,972,697

[3] Stone, Norbide, New Abrasive, Next to Diamond in Hardness, Product of Two Commonplace Materials: Vol. 55, no. 11, November 1934, pp. 464–465.

MISCELLANEOUS ABRASIVE MATERIALS

In addition to the materials already discussed, several other commodities are used for abrasive purposes. As they are highly diverse, some being natural and others artificial abrasives, they are considered briefly as a miscellaneous group.

Abrasive diamonds.—In the United States diamonds are produced at one locality—near Murfreesboro, Pike County, Ark. About 300 carats of gem stones and bort were produced in 1932, but no production was reported for 1933 or 1934. Imports of abrasive diamonds in 1934 were valued at about $2,900,000, an increase of 124 percent over 1933.

There are two types of abrasive or industrial diamonds—the black diamond (carbonado) and bort. Black diamonds, which are found chiefly in the State of Bahia (Brazil), are harder than the gem varieties and are especially valuable for cutting tools because they have no cleavage. The other variety (bort), obtained principally from South Africa, consists of cull stones from gem diamonds. Both varieties are used for abrasive purposes. Industrial diamonds are widely used in drill bits for drilling and boring rock. Diamond-toothed saws are used extensively for sawing marble, limestone, and other varieties of dimension stone. General information on abrasive diamonds may be found in a report by Tyler.[4]

Abrasive sand.—Figures on production of abrasive sand are included with those of related materials in the chapter on sand and gravel. In 1933, 572,735 short tons of sand valued at $739,222 were reported as used for abrasive purposes; preliminary figures indicate that the output in 1934 was about the same as in 1933.

Sand is used extensively in sawing and rubbing granite, limestone, marble, slate, and soapstone. "Chats" (tailings from the Joplin lead-zinc region) are used to some extent in the Indiana limestone district as a substitute for sand in sawing. Sand is used also for removing surface inequalities in crude-rolled plate glass before grinding and polishing, and in sand-blasting.

Other miscellaneous abrasives.—An artificial abrasive consisting of tin oxide or a mixture of tin oxide and oxalic acid, termed "putty powder", is used for polishing marble and granite. Rouge and crocus, forms of ferric oxide, are employed to produce a high luster—the former on precious metals and the latter on tin and cutlery. Rouge is used also for final polishing of plate glass. Chromium oxide, manganese dioxide, and magnesia have limited use as abrasives. River silt is employed to a limited extent in cleansing powders and in the manufacture of bath bricks; clay as a mild abrasive in some polishes and cleansing soaps and highly burned clay (sometimes ground to dust) in metal polishes; talc for polishing peanuts and rice; a pure high-grade lime, as well as whiting, for polishing surgical instruments and cutlery; chalk as a mild abrasive for polishing plated ware and in a number of window-cleaning compounds; and pulverized feldspar in certain soaps and cleaning compounds.

[4] Tyler, Paul M., Abrasive and Industrial Diamonds: Inf. Circ. 6562, Bureau of Mines, 1932, 25 pp.

FOREIGN TRADE

The total value of abrasive materials imported for consumption in the United States in 1934 was $3,405,881, of which 86 percent was industrial diamonds; the value of the imports was 102 percent higher than in 1933. Exports increased 11 percent in value in 1934, the greatest gain being in exports of "all other natural abrasives, hones, whetstones, etc.", which increased 60 percent over 1933.

The following tables summarize the value of abrasive materials imported for consumption in the United States from 1930 to 1934; the quantity and value of imports from 1932 to 1934, by kinds; and the value of domestic abrasive materials exported from the United States from 1930 to 1934.

Value of abrasive materials imported for consumption in the United States, 1930–34

Material	1930	1931	1932	1933	1934
Millstones and burrstones	$7,050	$2,435	$1,794	$1,123	$2,172
Grindstones	66,677	39,171	14,196	13,615	14,085
Hones, oilstones, and whetstones	40,612	24,881	15,543	29,968	35,143
Emery and corundum	329,752	151,501	107,199	170,921	256,423
Garnet	----------	149	356	20	----------
Tripoli and rottenstone	46,478	53,581	39,055	57,029	37,853
Pumice	94,387	77,168	51,062	75,422	83,272
Diamond:					
Dust and bort	90,945	20,292	12,860	47,092	68,982
Glaziers' and engravers', unset, and miners'	2,756,630	2,400,879	1,061,823	1,263,156	2,862,349
Flint, flints, and flint stones, unground	62,463	54,623	27,217	29,485	45,602

Abrasive materials imported for consumption in the United States, 1932–34, by kinds

Kind	1932		1933		1934	
	Quantity	Value	Quantity	Value	Quantity	Value
Millstones and burrstones:						
Rough or unmanufactured short tons	2	$200	9	$416	6	$483
Bound up into millstones do	18	1,594	17	707	17	1,689
Grindstones, finished or unfinished do	310	14,196	413	13,615	379	14,085
Hones, oilstones, and whetstones do	71	15,543	84	29,968	68	35,143
Emery:						
Ore do	674	5,724	701	6,398	3,428	41,537
Grains, ground, pulverized, or refined pounds	(1)	(1)	(1)	(1)	(1)	(1)
Paper and cloth of emery or corundum pounds	(2)	60,054	(2)	63,181	(2)	26,185
Wheels, files, and other manufactures of which emery or corundum is the material of chief value pounds	77,327	32,226	100,778	48,833	81,131	47,882
Corundum (see also "Emery"):						
Ore short tons	188	8,258	1,036	49,442	2,187	134,884
Grains, ground, pulverized, or refined pounds	[1] 21,348	[1] 937	[1] 48,257	[1] 3,067	[1] 91,855	[1] 5,935
Garnet in grains or ground, pulverized, etc. short tons	5	356	(3)	20	----------	----------
Tripoli and rottenstone do	2,098	39,055	4,119	57,029	1,587	37,853
Pumice:						
Crude or unmanufactured do	4,438	35,464	6,796	55,826	7,091	60,343
Manufactures of, or of which pumice is the component material of chief value short tons	(4)	15,598	(4)	19,596	(4)	22,929
Diamond:						
Bort carats	962	12,460	3,059	46,936	1,838	37,820
Dust pounds	(4)	400	(4)	156	(4)	31,162
Glaziers' and engravers', unset, and miners' carats	163,704	1,061,823	263,484	1,263,156	526,007	2,862,349
Flint, flints, and flint stones, unground short tons	3,754	27,217	4,640	29,485	5,154	45,602
	----------	1,331,105	----------	1,687,831	----------	3,405,881

[1] Emery included with corundum; not separately classified.
[2] 9,394 reams in 1932, 7,053 reams in 1933, and 2,956 reams in 1934; weight not recorded.
[3] Less than 1 ton.
[4] Quantity not recorded.

Value of domestic abrasive materials exported from the United States, 1930–34

Material	1930	1931	1932	1933	1934
Grindstones	$246, 512	$104, 602	$85, 528	$88, 950	$143, 626
Abrasive wheels, emery and other	203, 371	115, 076	64, 069	213, 087	113, 118
All other natural abrasives, hones, whetstones, etc	361, 055	232, 196	147, 469	158, 812	254, 131

Data relating to tariffs on abrasive materials are given in Minerals Yearbook, 1934, page 906.

SULPHUR AND PYRITES [1]

By Robert H. Ridgway and A. W. Mitchell

SUMMARY OUTLINE

Continued industrial activity throughout the world in 1934 served to maintain the sulphur industry at about the same level attained in 1933, and world production of native sulphur, supplemented by the recovery of elemental sulphur from pyrites, showed a small increase. Stocks at the mines decreased due to excess of shipments over output by American producers who maintain extensive mined reserves.

Probably the most important event in the sulphur industry in 1934 was the formation of a new agreement between the Sulphur Export Corporation (American) and the Central Sulphur Sales Bureau (Italian). The latter organization was formed by government action late in 1933 in an attempt to alleviate conditions in the Italian sulphur industry resulting from discontinuance of the Sicilian Sulphur Consortium in 1932 and the consequent lapsing of the Sicilian-American marketing agreement. The new agreement provides for the allocation of world markets between the two principals, excluding, however, North America and Italy. Both parties are obligated not to sell under the minimum price agreed on.

The price of sulphur, as quoted by domestic trade journals, remained unchanged throughout the year. Prices in certain foreign markets, which have been weak during the past 2 years, may be steadied as a result of the new American-Italian agreement.

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

The United States continued to be by far the major factor in the world production of sulphur in 1934. Italy, the second largest producing country, maintained production at approximately the level of the 1933 output, which was the largest since 1914. Japanese production in recent years has been increasing and probably was greater in 1934 than in 1933. Norway continued to be a factor in the market, with a sizable production and exportation of sulphur obtained in the treatment of pyrites. Spain is augmenting its output of elemental sulphur from pyrites in a plant similar to that operating in Norway. A similar plant also is being constructed at the principal pyrite mine in Portugal.

As usual, Spain was the most important source of pyrites in the world; Norway, the next largest producer, had an increased output.

Consumption of sulphur in the United States declined slightly, while that of pyrites increased. In the sulphur industry the year

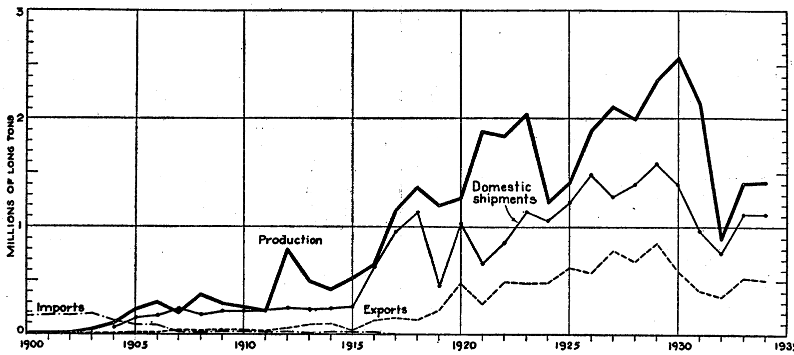

FIGURE 111.—Domestic production, domestic shipments, exports, and imports of crude sulphur, 1900–1934.

was characterized by slightly increased production, slightly decreased shipments (both domestic and export), decreased stocks due to excess of shipments over production, and a steady price. The following table outlines the principal features of the domestic situation in recent years.

Salient statistics of the sulphur industry in the United States, 1925–29 and 1932–34

	1925–29 average	1932	1933	1934
Sulphur:				
Production of crude sulphur____long tons__	1, 951, 034	890, 440	1, 406, 063	1, 421, 473
Shipments of crude sulphur:				
For domestic consumption____do____	1, 397, 411	756, 242	1, 114, 853	1, 110, 526
For export____do____	707, 175	352, 610	522, 515	503, 312
Total shipments____do____	2, 104, 586	1, 108, 852	1, 637, 368	1, 613, 838
Imports____do____	1, 896	____	4, 773	5, 839
Exports of treated sulphur____do____	11, 956	7, 270	8, 763	10, 116
Producers' stocks at end of year [1]____do____	2, 413, 000	3, 500, 000	3, 300, 000	3, 100, 000
Price of crude sulphur f. o. b. mines, per long ton__	$17. 50	$18	$18	$18
Pyrites:				
Production____long tons__	273, 936	189, 703	284, 311	432, 524
Imports____do____	373, 186	253, 248	374, 417	366, 315
Price of imported pyrites c. i. f. Atlantic ports, cents per long-ton unit____	12–13	12–13	12–13	12–13
Sulphuric acid: Production of byproduct sulphuric acid at copper and zinc plants 60° B____short tons__	1, 118, 453	600, 334	656, 102	575, 660

[1] Revised figures.

No codes were formulated for the sulphur or pyrites producers during the year. In the sulphuric acid industry some producers contended that the acid produced as a byproduct at zinc plants should come under the zinc code and that the acid produced at fertilizer works should come under the fertilizer code. All sulphuric acid,

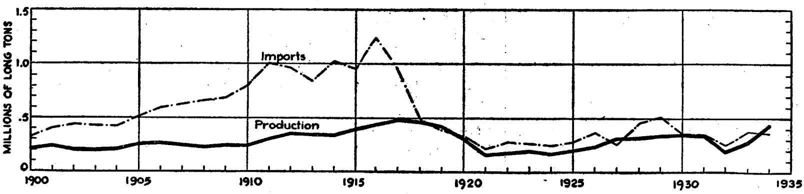

FIGURE 112.—Domestic production and imports of pyrites, 1900–1934.

however, was placed under the chemical code, which was approved in February 1934.

The principal trends in the sulphur and pyrites industries in the United States during the twentieth century are shown in figures 111 and 112. Before 1900 the production of sulphur in this country was very small.

SULPHUR

Domestic production.—Production of sulphur in the United States in 1934 totaled 1,421,473 long tons, a slight increase over the 1,406,063 tons produced in 1933. Shipments, however, declined slightly, amounting to 1,613,838 tons valued at $28,900,000 in 1934 compared with 1,637,368 tons valued at $29,500,000 in 1933.

The following table records American sulphur production from 1930 to 1934.

Sulphur produced and shipped in the United States, 1930–34

Year	Produced (long tons)	Shipped		Year	Produced (long tons)	Shipped	
		Long tons	Approximate value			Long tons	Approximate value
1930	2, 558, 981	1, 989, 917	$35, 800, 000	1933	1, 406, 063	1, 637, 368	$29, 500, 000
1931	2, 128, 930	1, 376, 526	24, 800, 000	1934	1, 421, 473	1, 613, 838	28, 900, 000
1932	890, 440	1, 108, 852	20, 000, 000				

Eighty-four percent of the domestic sulphur production reported for 1934 came from Texas and the bulk of the remainder from Louisiana. California, with a small but increasing output, contributed 4,410 tons. Thus the two States, Texas and Louisiana, together produced more than 99 percent of the domestic output.

The following table lists the sulphur mines in the United States active in 1934.

Mines that produced sulphur in the United States in 1934

Operating company	Name of mine	Location of mine
Leviathan Sulphur Co	Leviathan	Alpine County, Calif.
Henry Babineau	Sulphur Queen	Inyo County, Calif.
Grover Kihorney	do	Do.
Do	Hog Back	Do.
Smith, Carsten, & Associates	Crater	Do.
West Coast Sulphur Co	do	Do.
Jefferson Lake Oil Co., Inc	Lake Peigneur	Iberia Parish, La.
Freeport Sulphur Co	Grande Ecaille	Plaquemines Parish, La.
Do	Bryan Mound	Freeport, Brazoria County, Tex.
Do	Hoskins Mound	Do.
Duval Texas Sulphur Co	Palangana Dome	Benavides, Duval County, Tex.
Texas Gulf Sulphur Co	Long Point Dome	Long Point, Fort Bend County, Tex.
Do	Boling Dome	Newgulf, Wharton County, Tex.

Stocks.—For the third consecutive year shipments have exceeded production, resulting in a further decrease in stocks at the mines. Such stocks, however, are still large, amounting to 3,100,000 long tons on December 31, 1934, or 200,000 tons below the reserve at the end of 1933. The above stock data represent revisions of figures in previous reports of this series due to revision of inventories by one of the larger sulphur producers.

Price.—The average quoted price for sulphur, as reported by the trade journals, was unchanged at $18 a ton f. o. b. mines throughout 1934. Spot prices for car lots were given at $21 per ton.

Byproduct sulphur.—A large quantity of sulphur is recovered each year as a byproduct from copper and zinc milling and smelting. Treatment of some copper and zinc ores yields a pyrites concentrate, which is an important source of sulphur, as well as copper and zinc concentrates. Production of pyrites concentrate is discussed in the pyrites section of this report. In smelting copper and zinc concentrates the sulphur is driven off as sulphur dioxide gas, which is used in the manufacture of sulphuric acid at many smelters. Nearly 200,000 tons of sulphur were recovered annually from this source during the 5 years ended in 1933. Such sulphur is not included in the sulphur-production figures for the United States.

The following table gives the output of sulphuric acid as a byproduct at both copper and zinc smelting plants and represents virtually all the byproduct acid produced in the United States. The acid reported is only that made from the sulphur content of the sulphide ores. The figures for 1934 do not include the acid made from the pyrites concentrate in Tennessee but do include the relatively small amount of acid made from pyrites concentrate in Wisconsin. For previous years pyrites acid from both States is included. The figures for production of acid at copper plants include that made at Anaconda in 1932 and preceding years but exclude it for 1933 and 1934.

Byproduct sulphuric acid (expressed as 60° B.) produced at copper and zinc plants in the United States, 1930–34, in short tons

	1930	1931	1932	1933	1934
Copper plants	651, 702	436, 111	258, 994	[1] 301, 075	[1 2] 168, 676
Zinc plants	536, 614	426, 618	341, 340	355, 027	406, 984
	1, 188, 316	862, 729	600, 334	[1] 656, 102	[1 2] 575, 660

[1] Excludes acid made by Anaconda Copper Mining Co. Part of the acid made by this company in 1931 and 1932 was from pyrites concentrates and all of the acid made in 1933 and 1934 was from this source.
[2] Excludes acid made from pyrites concentrates in Tennessee.

A small amount of byproduct sulphur is produced annually incident to the purification of manufactured fuel gas. In 1934, 1,500 long tons of sulphur were produced from this source. Only a minor part of the output is marketed; the remainder is stored or accumulated in dumps at the various plants. Such output is not included in the sulphur production figures for the United States. The Thylox gas-purification process has been described by Gollmar.[2]

Consumption.—The apparent consumption of sulphur in 1934 was maintained virtually at the 1933 level and was greater than in 1932 or 1931. The trend of sulphur consumption in the United States for the last 5 years is shown in the following table, assuming that stocks in consumers' hands are small and constant.

Apparent consumption of sulphur in the United States, 1930–34, in long tons

	1930	1931	1932	1933	1934
Shipments	1,989,917	1,376,526	1,108,852	1,637,368	1,613,838
Imports	29			4,773	5,839
	1,989,946	1,376,526	1,108,852	1,642,141	1,619,677
Exports:					
Crude	593,312	407,586	352,610	522,515	503,312
Refined	16,014	12,142	7,270	8,763	10,116
	609,326	419,728	359,880	531,278	513,428
Apparent consumption	1,380,620	956,798	748,972	1,110,863	1,106,249

The consumption of sulphur in the various domestic industries for the last 5 years has been estimated as follows by Chemical and Metallurgical Engineering:

Sulphur consumed in the United States, 1930–34, by uses, in long tons

Use	1930	1931	1932	1933	1934
Heavy chemicals	471,000	327,000	298,000		
Electrochemicals	20,000	16,000	13,000	491,000	512,000
Fine chemicals	13,000	12,000	10,000		
Fertilizer and insecticides	418,000	254,000	155,000	242,000	247,000
Pulp and paper	235,000	178,000	153,000	197,000	176,000
Explosives	48,000	39,000	27,000	37,000	43,000
Dyes and coal-tar products	41,000	39,000	34,000	40,000	34,000
Rubber	31,000	23,000	18,000	24,000	30,000
Paint and varnish	4,500	4,000	4,000	4,000	4,000
Food products	4,500	4,700	4,000	4,000	4,000
Miscellaneous	110,600	72,000	40,000	75,000	60,000
	1,396,600	968,700	756,000	1,114,000	1,110,000

Production of sulphuric acid, the chief use of sulphur in the United States, increased slightly in 1934 over 1933, due to moderate increases in consumption in a rather wide range of industrial applications. The principal consumer—the fertilizer industry—required 16 percent more acid than in 1933, constituting the largest increase. Although sulphur appears to be highly essential to all plant life, its principal commercial application in the fertilizer industry at present is in the treatment of phosphate rock by sulphuric acid. In this process, sulphuric acid and

[2] Gollmar, H. A., Chemistry of the Thylox Gas-Purification Process: Ind. and Eng. Chem., Ind. Ed., vol. 26, no. 2, February 1934, pp. 130–132.

phosphate rock are mixed in about equal proportions; the resultant reactions render the phosphorus content of the rock soluble and thus available for plant food. Recent research,[3] which has demonstrated that calcination also renders the phosphorus content of phosphate rock soluble, indicates a change in technic that may affect the consumption of sulphuric acid in the fertilizer industry. The second largest consumer of sulphuric acid, the petroleum industry, increased its output of motor fuel and lubricating oil but slightly decreased its consumption of acid; in fact, the consumption of acid by the petroleum industry has dropped each year since 1929. Although the figures in the table are estimates the decline in acid consumption undoubtedly indicates that certain grades of gasoline do not receive as extensive treatment as previously and that technical developments and new processes for refining petroleum products tend to eliminate the use of sulphuric acid. The following table, which shows the consumption of sulphuric acid by industries from 1930 to 1934, is based largely on estimates by Chemical and Metallurgical Engineering. The figures on acid consumed by the fertilizer industry are those supplied by the Bureau of the Census.

Sulphuric acid (expressed as 50° B.) consumed in the United States, 1930–34, by industries, in short tons [1]

Industry	1930	1931	1932	1933	1934
Fertilizer [2]	2,477,000	1,351,000	771,000	1,206,000	1,396,000
Petroleum refining	1,420,000	1,348,000	1,240,000	1,140,000	1,100,000
Chemicals	820,000	760,000	674,000	725,000	765,000
Coal products	800,000	570,000	375,000	468,000	535,000
Iron and steel	660,000	480,000	270,000	390,000	475,000
Other metallurgical	560,000	410,000	310,000	360,000	390,000
Paints and pigments	200,000	180,000	160,000	170,000	210,000
Explosives	177,000	175,000	120,000	140,000	180,000
Rayon and cellulose film	145,000	183,000	176,000	242,000	230,000
Textiles	78,000	81,000	75,000	90,000	75,000
Miscellaneous	330,000	262,000	230,000	223,000	250,000
	7,667,000	5,800,000	4,401,000	5,154,000	5,606,000

[1] Figures, except those for fertilizer industry, from Chem. and Met. Eng., January 1935, p. 45, and from earlier annual review issues.
[2] Bureau of the Census, Department of Commerce.

Melted sulphur mixed with inert fillers, such as sand, portland cement, or stone dust, makes a satisfactory pouring cement. Sulphur cements of greatest tensile strength are obtained by mixing 40 percent of sulphur and 60 percent of sand. Both workability and strength are increased by adding small percentages of carbon black. These cements are highly resistant to acid but are attacked by oils and concentrated alkaline solutions.[4]

Sulphur has long been used as an insecticide and fungicide. A new colloidal bentonite-sulphur has been described by McDaniel.[5]

[3] Reynolds, D. S., Jacob, K. D., and Rader, L. F., Jr., Phosphate Fertilizers by Calcination Process· Ind. and Eng. Chem., vol. 26, no. 4, April 1934, pp. 406–412. Brown, B. E., Reid, F. R., and Jacob, K. D., Fertilizer Value of Phosphate Rock Improved by Treatment with Water Vapor at High Temperatures: Am. Fertilizer, vol. 81, no. 13, Dec. 29, 1934, pp. 5–7, 27. Reynolds, D. S., Jacob, K. D., Marshall, H. L., and Rader, L. F., Jr., Phosphate Fertilizers by Calcination Process: Ind. and Eng. Chem., vol. 27, no. 1, January 1935, p. 87. Marshall, H. L., Reynolds, D. S., Jacob, K. D., and Rader, L. F., Jr., Phosphate Fertilizers by Calcination Process: Ind. and Eng. Chem., vol. 27, no. 2, February 1935, pp. 205–209.
[4] Duecker, Werner W., Admixtures Improve Properties of Sulphur Cements: Chem. and Met. Eng. vol. 41, no. 11, November 1934, pp. 583–586.
[5] McDaniel, A. S., Colloidal Bentonite-Sulphur: Ind. and Eng. Chem., vol. 26, no. 3, March 1934, pp. 340–345.

Kress and others[6] describe the construction and operation of the spray-type sulphur burner developed by the research department of the Texas Gulf Sulphur Co.

Foreign trade.—Imports of sulphur ore in 1934 were 5,839 long tons compared with 4,773 tons in 1933. Chile supplied the total quantities received in the United States in 1933 and 1934.

Exports amounted to 503,312 tons in 1934 compared with 522,515 tons in 1933, a decrease of 4 percent.

Sulphur imported into and exported from the United States, 1930–34

Year	Imports for consumption[1]		Exports			
			Crude		Crushed, ground, refined, sublimed, and flowers of	
	Long tons	Value	Long tons	Value	Long tons	Value
1930	29	$1,523	593,312	$12,416,233	16,014	$556,029
1931			407,586	8,837,268	12,142	431,785
1932			352,610	7,178,566	7,270	266,210
1933	4,773	67,432	522,515	9,877,879	8,763	316,890
1934	5,839	76,631	503,312	9,294,228	10,116	399,843

[1] From 1930 to 1932 classified as "sulphur and sulphur ore." Classified as "sulphur ore" in 1933 and in 1934.

In addition to brimstone or crude sulphur the United States exports treated products, such as crushed, ground, refined, and sublimed sulphur and flowers of sulphur. Exports of these commodities in 1934 totaled 22,660,890 pounds valued at $399,843, an increase of 15 percent over 1933; the average value in 1934 was 1.76 cents per pound or about $39 per ton.

Canada, with an increase of 18 percent over 1933, continued to be the best customer for American crude sulphur, taking 145,384 long tons or 29 percent of the total exports in 1934. France with 14 percent, United Kingdom with 12 percent, and Australia with 9 percent followed in order. Together these four countries imported 64 percent of the total crude sulphur shipped from the United States.

In 1934 Canada, which also imports the largest amount of American treated sulphur, took 5,595,548 pounds (25 percent of the total); Australia with 2,415,621 pounds (11 percent) again ranked second; and the United Kingdom with 1,952,313 pounds (9 percent) increased its requirements greatly, advancing to third place. Mexico, Germany, Canary Islands, Asia, and Brazil followed in order; each required more than a million pounds in 1934.

Among the countries that received important quantities of American sulphur in 1934, Canada, Australia, United Kingdom, and Sweden increased their imports over 1933. The largest increase occurred in shipments to Canada, where the sulphur is consumed largely in paper manufacture. Australia also imported a greater quantity in 1934 than in 1933, but demand in New Zealand declined in 1934, resulting in a decrease in the total shipments to Australasia, where sulphur is consumed largely in the manufacture of fertilizers.

[6] Kress, O., Swanson, W. H., Porter, D. C., and Smith, B. F., The Texas Gulf Sulphur Co. Spray-Type Burner: Paper Trade Jour., vol. 99, no. 17, Oct. 25, 1934, pp. 48–51.

Shipments to the United Kingdom in 1934 were the largest ever recorded, and shipments to Sweden were the largest recorded since 1922. The other large consuming nations, located in Europe, required less sulphur in 1934 than in 1933. Shipments to Germany declined from 69,139 tons in 1933 to 38,819 tons in 1934, an amount equal to about 28 percent of the average shipments to Germany during the 5-year period 1926 to 1930. Much of the sulphur exported to Germany is transshipped to other European countries, consequently the lower figure in recent years reflects the lower demand for American sulphur, not only in Germany but also in nearby countries. The competition from pyrites in the pulp industry in the Scandinavian countries, the production of elemental sulphur from pyrites in Norway, and the output of byproduct sulphur from the gas industry in Germany all tend to lower the demand for American sulphur.

Sulphur exported from the United States in 1934, by destinations

Destination	Sulphur or brimstone		Crushed, ground, refined, sublimed, and flowers of	
	Long tons	Value	Pounds	Value
North America:				
Canada	145,384	$2,650,090	5,595,548	$110,446
Central America	114	3,829	144,816	4,212
Mexico	10,386	205,971	1,803,998	40,611
Newfoundland and Labrador	3,895	76,519	180	10
West Indies	9,353	173,030	191,191	6,680
	169,132	3,109,439	7,735,733	161,959
South America:				
Argentina	9,934	197,828	[1] 3,258	[1] 2,956
Brazil	1,792	40,543	1,299,912	21,956
Colombia			238,793	6,076
Uruguay			560,000	6,858
Other	19	560	178,441	3,308
	11,745	238,931	2,280,404	41,154
Europe:				
Belgium	3,510	71,224	166,177	2,033
Denmark			986,311	12,199
France	71,829	1,336,558	269,400	3,641
Germany	38,819	787,247	1,621,488	21,144
Netherlands	21,594	437,869	344,642	4,126
Sweden	30,963	562,899	243,785	3,169
United Kingdom	62,434	1,053,084	1,952,313	28,594
Other	28,935	517,351	777,787	10,200
	258,084	4,766,232	6,361,903	85,106
Asia	2,500	47,750	1,381,037	22,557
Africa:				
Algeria and Tunisia	6,400	121,700		
Canary Islands			1,414,715	28,351
Mozambique			105,000	1,784
Union of South Africa			805,994	13,015
Other			21,420	365
	6,400	121,700	2,347,129	43,515
Oceania:				
Australia	44,819	814,630	2,415,621	42,714
New Zealand	10,632	195,546	134,073	2,764
Other			4,990	74
	55,451	1,010,176	2,554,684	45,552
	503,312	9,294,228	22,660,890	399,843

[1] Material specially treated.

THE INDUSTRY IN 1934, BY STATES

TEXAS

Although over 99 percent of all domestic sulphur was produced in Texas from 1925 to 1932, inclusive, in 1933 and 1934 that State produced only 77 and 84 percent, respectively, despite an increasing output each year. Resumption of production in Louisiana accounts for this drop in relative output. The increased output in Texas during 1934 was shared by two producing companies, and the third producing company made part of its shipments from its new property in Louisiana. The following table, compiled from information issued by the Texas State Comptroller's Office, shows the quarterly production of sulphur in Texas for 1934.

Sulphur produced in Texas in 1934, by companies, in long tons

Company	First quarter	Second quarter	Third quarter	Fourth quarter	Total
Texas Gulf Sulphur Co.	191,955	208,814	234,165	210,494	845,428
Freeport Sulphur Co.	83,990	66,800	70,090	76,675	297,555
Duval Texas Sulphur Co.	15,420	13,475	9,944	5,856	44,695
	291,365	289,089	314,199	293,025	1,187,678

Texas Gulf Sulphur Co.—The plant at the older property of this company at Gulf, Matagorda County, was not operated in 1934; shipments, however, were made from stock. The smaller plant at Long Point, Fort Bend County, maintained normal production during 1934, but no shipments have been made as yet. The bulk of the output of this company came from Boling dome in Wharton County, which has been operated continuously since first production on March 20, 1929.

During 1934 the Texas Gulf Sulphur Co. acquired from the Delaware Gulf Oil Co. certain fee and royalty interests on sulphur properties in Texas in exchange for 1,300,000 shares of capital stock of the Texas Gulf Sulphur Co. The principal fee and royalty interests are on Boling dome and Long Point dome, which have been operated by the sulphur company under contractual agreements with the Gulf Production Co. The sulphur company has also acquired an option giving it the right to acquire all sulphur interests of the Gulf Production Co. in properties in Texas for 10 years after July 4, 1934 without additional consideration. The sulphur property at Gulf, Matagorda County, was already wholly owned in fee by the sulphur company.

Freeport Sulphur Co.—Production was continued at the two Texas plants of the company throughout 1934 at a lower rate than in 1933. The Bryan mound property of this company is nearing exhaustion.

Duval Texas Sulphur Co.—This company makes a relatively small output at Palangana dome in Duval County. Production fell during the year; during the fourth quarter it was only one-third of that during the first quarter. It was reported during the year [7] that the Duval Texas Sulphur Co. was erecting a plant at Boling dome with a daily capacity of 500 tons of sulphur.

[7] Chemical Industries, vol. 35, no. 4, October 1934, p. 346.

LOUISIANA

Production of sulphur was resumed in Louisiana in 1932 when 13,401 long tons was produced. The output amounted to 229,830 tons in 1934 compared with 321,492 tons in 1933. Two companies, the Jefferson Lake Oil Co., Inc., and the Freeport Sulphur Co., were the producers in 1934. The State severance tax on sulphur was increased from 27 to 60 cents per ton on August 1, 1934.

Freeport Sulphur Co.—In December 1933 the Freeport Sulphur Co. began to produce sulphur from the Grande Ecaille salt dome in Plaquemines Parish about 45 miles southeast of New Orleans. Production was continuous during 1934 and amounted to 153,362 long tons, according to the Supervisor of Public Accounts, State of Louisiana. The pumping of mud into the formations was continued during the year to obtain better thermal efficiency of the hot water used for production purposes. This process was developed by Freeport's engineers in overcoming similar difficulties in the development of Hoskin's mound.

Jefferson Lake Oil Co.—This company continued to produce sulphur at the Jefferson Island salt dome but at a lower rate than in 1933. According to the Supervisor of Public Accounts, State of Louisiana, the output totaled 75,802 long tons in 1934.

CALIFORNIA

Six operators in California produced 4,410 long tons of sulphur in 1934. The largest producer was the West Coast Sulphur Co., which leased the Crater group of claims in Inyo County on July 6, 1934. Production from this property during the first half of the year was reported by Smith, Carsten, and associates. The Crater group is 27 miles south of Oasis and 62 miles by road from Zurich, a station on the Southern Pacific Railroad. The ore contains about 85 percent sulphur, is produced from opencuts and underground operations, and is shipped to Los Angeles or San Francisco, where it is used for making sulphuric acid. The Hog Back and Sulphur Queen mines also produced sulphur in Inyo County in 1934.

The Leviathan Sulphur Co. continued to produce sulphur in 1934 from its Leviathan mine in Alpine County about 10 miles east of Markleeville. The sulphur at this property occurs in an andesitic tuff, and the ore is said to carry 40 percent sulphur. The ore is crushed and retorted, and the product (which contains 99.5 percent sulphur) is shipped to San Francisco.

OTHER STATES

Utah.—No production was reported by the Utah Sulphur Industries, which is experimenting and adding new equipment.

New Mexico.—Development work but no production was reported from the sulphur deposits near Jemez Springs.

WORLD PRODUCTION

World production of sulphur in 1934, including the sulphur recovered in Norway and Spain from the treatment of pyrites and in Germany from gas manufacture, amounted to approximately 2,025,000 long tons.

The following table shows production in the principal producing countries during the last 5 years.

Production of sulphur in the principal producing countries, 1930–34, in long tons

Year	United States (sulphur)	Italy		Japan		Chile (sulphur)	Spain (sulphur)
		Sulphur	Ore	Sulphur	Ore		
1930	2,558,981	345,026	19,409	61,375	14,392	18,184	11,557
1931	2,128,930	348,132	19,502	60,528	2,195	5,018	10,867
1932	890,440	344,450	25,119	83,195	2,591	8,459	8,113
1933	1,406,063	370,724	24,569	102,412	(1)	12,311	27,178
1934	1,421,473	346,000	(1)	(1)	(1)	(1)	(1)

1 Data not available.

ITALY

Preliminary reports indicate that the production of sulphur in Italy in 1934 was 346,000 long tons, compared with 370,724 tons in 1933. The mines on the Continent produced about 99,000 tons while those on the Island of Sicily contributed the remaining 247,000 tons. Exports of sulphur from Italy in 1934 were 215,482 tons, a small decrease from the 217,671 tons exported in 1933.

The unsatisfactory conditions in the sulphur industry in Italy, particularly in Sicily, were aggravated further in 1933 by depreciation of the American dollar. To alleviate the distress somewhat, the Government formed a Central Sulphur Sales Bureau late in 1933 to handle all domestic and foreign sales of Italian sulphur and to guarantee the producers a preestablished minimum price for their product. The Bureau then inaugurated a policy of selling Italian sulphur on European markets at prices below the quotations for American sulphur. Although a certain amount of sulphur was disposed of in this manner the experiment proved much more costly than had been anticipated, and the results fell short of expectations, particularly in Sicily. The cost of maintaining the new Central Sulphur Sales Bureau—some 3,000,000 lire per year—was an added charge against the sulphur-producing industry. The Bureau did, however, offer a united front of all Italian producers, which undoubtedly facilitated agreement with the American exporters. The first attempts at such agreement in 1934 were unsuccessful because the Italians insisted on a substantial increase in selling price, ostensibly because of the heavy subsidies the Italian Government contributes to prevent the collapse of the industry. The American interests, however, objected to any considerable rise in the price of sulphur because of the threat of encouraging outside production, principally production of elemental sulphur from pyrites, especially in countries with depreciated national currency.

An agreement, however, was finally reached in July at a meeting in London. It provides that annual exports up to 480,000 tons shall be divided equally between the American and Italian sulphur-producing interests; on sales over this tonnage 75 percent is allotted to American and 25 percent to Italian sulphur. This tonnage refers to sulphur consumed all over the world, except in North America and Italy. Only a small increase in price was conceded, ranging from 50 cents to $1 a ton, dependent on the market, but both parties are obligated not to sell under the stated minimum price. It is expected that the agreement will have a stabilizing effect in Sicily, even though the Government subsidy is still necessary. The Italian Government continued to pay producers a guaranteed minimum price, which was established by decree of July 14, 1934, for the fiscal year 1934–35 as follows:

Grade:	*Lire per ton*
Superior Yellow	282
Inferior Yellow	272
Good	264
Ordinary	256

Further relief was afforded the Italian sulphur industry in 1934 through reduction of the fixed tax from 3.50 to 2.50 lire per ton on crude or refined sulphur exported from Sicily or shipped to the mainland and on crude sulphur produced on the mainland. This particular tax represents a single tax on sulphur introduced in 1932 to replace various State, provincial, and municipal taxes.

JAPAN

Sulphur output in Japan has been increasing during the past few years and during the 3 years from 1931 to 1933 the increase amounted to 69 percent. Exports of sulphur also were much larger—44,929 long tons in 1934 compared with 31,607 tons in 1933 and 25,587 tons in 1932.

The sulphur deposits of the two largest sulphur mines in Japan, namely, the Matsuo mine in the Province of Rikuchu on the northeastern mainland and the Horobets mine in the Province of Iburi, in Hokkaido, have been studied by Kato, Watanabe, and Nakamoto [8] who reached the following conclusions regarding the deposition of the sulphur:

> The sulphur deposits now being worked at the Horobets and Matsuo mines were deposited in boiling lakes accompanied by the action of hot springs and solfataras at the bottom of explosion craters formed in the Pleistocene epoch. They were later covered by sedimentary and pyroclastic materials or by recent lava flows. The manner of formation of deposits of this type is actually being demonstrated in nature in the volcanic districts adjacent to the Matsuo and Horobets mines.

SPAIN

The output of sulphur in Spain was 27,178 long tons in 1933 compared with 8,113 tons in 1932. This large increase was due to the production of about 15,000 tons of elemental sulphur from pyrite by the Rio Tinto Co. in the Huelva district. The change in the position of Spain in the world sulphur market is illustrated by the following table.

[8] Kato, Takeo, Watanabe, Takeo, and Nakamoto, Akira, On the Sulphur Deposits Associated with Iron Sulphide Ore, Found in the Quarternary Formation of Japan: Japanese Jour. Geol. and Geog., vol. 11, nos. 3 and 4, 1934, pp. 287–324.

Sulphur imported into and exported from Spain, 1932–34, in long tons

Year	Imports	Exports
1932	10,351	826
1933	3,954	900
1934	675	2,942

CHILE

The output of sulphur in Chile in 1934 is estimated at 16,000 long tons. Exports were 16,531 tons, of which about 71 percent went to other countries in South America and the remainder to the United States and Europe.

PORTUGAL

The new plant for the production of elemental sulphur from pyrite at the San Domingos mine in the Province of Alemtejo is expected to have a capacity of 120 tons of ore daily, or an annual output of 10,000 tons of sulphur. The plant was to have begun operation in the latter part of 1934.

GERMANY

Germany has no commercial deposits of native sulphur, and in the past its requirements have been met by imports, largely from the United States. Recently, however, successful processes for the recovery of sulphur in the manufacture of various industrial gases, such as coke-oven gas, generator gas, water gas, and others, have been applied, but the production has not been appreciable until the past 3 years. The entire German production of sulphur is estimated at about 12,000 tons in 1934. The consummation of the American-Italian sulphur agreement may be an added impetus to the production of byproduct sulphur in Germany.

NORWAY

Sulphur is produced on a commercial scale in Norway by the Orkla process at the Thamshavn plant of the Orkla Metal Co., a subsidiary of the Orkla Mining Co. Data on the output in 1934 are not yet available, but it may be estimated at 65,000 tons. Exports of sulphur from Norway in 1934 reached a total of 65,734 long tons. Ninety-eight percent of the Norwegian exports of sulphur went to Finland and Sweden, the former taking 56 percent; the remainder went to Poland and Germany.

The following table, compiled from official sources, shows imports and exports of sulphur in Norway from 1929 to 1934.

Sulphur imported into and exported from Norway, 1929–34, in long tons [1]

Year	Imports	Exports			Year	Imports	Exports		
		Domestic	Other	Total			Domestic	Other	Total
1929	17,551	574	203	777	1932	11,138	46,116	1	46,117
1930	16,480	1,339	199	1,538	1933	7,957	58,950		58,950
1931	6,347	6,393		6,393	1934	10,997	65,734		65,734

[1] Manedsopgaver over Vareomsetningen med Utlandet.

OTHER COUNTRIES

Less important quantities of sulphur are produced in Bolivia,[9] China, Greece, Mexico, Netherland East Indies, New Zealand, Southern Rhodesia, and the U. S. S. R. (Russia). Recent reports indicate that large reserves of sulphur have been discovered in Soviet Russia during the past several years. Activities in sulphur exploration were also reported from Mexico, Palestine, Turkey, and Canada.[10]

PYRITES

Domestic production.—Production of pyrites (ores and concentrates) in the United States amounted to 432,524 long tons in 1934, an increase of 52 percent over the production of 284,311 tons in 1933. The following table gives production during the past 5 years.

Pyrites (ores and concentrates) produced in the United States, 1930–34

Year	Quantity		Value	Year	Quantity		Value
	Gross weight (long tons)	Sulphur content (percent)			Gross weight (long tons)	Sulphur content (percent)	
1930	347,512	35.7	$1,028,680	1933	284,311	37.9	$769,942
1931	330,848	36.7	974,820	1934	432,524	38.8	1,216,363
1932	189,703	35.0	498,570				

Of the total production in 1934, 91,082 long tons were lump and the remainder fines, the bulk of the latter being flotation concentrates. The sulphur content of the pyrites produced was 38.8 percent (167,645 tons of sulphur) compared with 37.9 percent (107,778 tons) in 1933.

The quantity of pyrites (ores or concentrates) sold or consumed by the producing companies totaled 431,340 long tons in 1934 compared with 282,583 tons in 1933. In 1934, 118,173 tons were sold by producers, all to domestic consumers. The prices of pyrites quoted by the trade journals are those for imported pyrites and are given in cents per long-ton unit c. i. f. Atlantic ports; the average quoted was 12 to 13 cents per long-ton unit throughout the year.

Tennessee was the principal producing State in 1934; other producers were California, Colorado, Missouri, Montana, New York, Virginia, and Wisconsin.

THE INDUSTRY IN 1934, BY STATES

California.—Pyrites was produced from two mines in California in 1934—the Leona Heights mine at Oakland, Alameda County, and the Hornet mine in Shasta County. As a result of research by the Bureau of Mines on the reduction of ores by natural gas, a pilot plant with a capacity of 1 ton a day was installed by the Mountain Copper Co. at Martinez, Calif., for the production of iron from the sinter resulting from the roasting of the pyrite. Pilot-plant operations were fully as successful as was predicted from laboratory studies.

[9] Griffith, S. V., Sulphur in Bolivia and Peru: Min. Mag. (London), vol. 51, no. 1, July 1934, pp. 15–20.
[10] Bureau of Foreign and Domestic Commerce, World Trade Notes—Sulphur Discovery Reported in Ontario: Vol. 8, no. 4, Mar. 31, 1934, p. 3.

Colorado.—Shipments of 5,303 long tons of pyrites in 1934 were made from the mill-tailings dump of the Colorado Zinc-Lead mill in Lake County. The pyrites, which averaged 35 percent sulphur, was shipped to the Denver plant of the General Chemical Co., where it is used for the manufacture of sulphuric acid.

Missouri.—Three operators (2 mines) in Crawford County, 2 in Franklin County, and 2 in Phelps County reported a production of 14,557 long tons of pyrites in 1934 compared with 4 mines producing 18,355 tons in 1933.

The largest output came from the operations of H. H. Lark in Crawford County. The Hobo mine near Bourbon in Crawford County continued to produce in 1934. The Rueppele mine in Franklin County was shut down the latter part of March and probably never will reopen. Pyrites was also produced at the Mohawk mine in Franklin County and the Moselle mine No. 10 in Phelps County.

The bulk of the pyrites produced in Missouri is marcasite, and the sulphur content ranges from 40 to 49 percent; the average sulphur content of the 1934 production was 45 percent. The 1934 output was shipped to the Evans-Wallower Zinc Co., at East St. Louis, Ill., and to the Titanium Pigment Co., at St. Louis, Mo., where it is roasted for acid manufacture.

Montana.—The pyrites produced in Montana in 1934 came from the Anaconda Copper Mining Co., at Anaconda, Mont., where it is recovered as a flotation concentrate in the copper-plant operation.

New York.—During 1934 the St. Joseph Lead Co. produced 31,674 long tons of pyrites concentrates at its Balmat mine in St. Lawrence County. The pyrites, which ran 49.9 percent sulphur, was produced as a flotation concentrate in the treatment of ore in which zinc is the principal value.

Tennessee.—The pyrites produced in Tennessee in 1934 came from operations of the Tennessee Copper Co. and the Ducktown Chemical & Iron Co., both in the Ducktown Basin, Polk County. The pyrites from Tennessee is a flotation concentrate and does not enter the market, as both companies use all of their product in the manufacture of sulphuric acid.

Virginia.—The only pyrites mined in Virginia in 1934 came from the Gossan mine at Cliffview, Carroll County, operated by the General Chemical Co. The ore, both lump and fines, is mined by opencut and underground methods and is used in the manufacture of sulphuric acid in the company plant at Pulaski.

Wisconsin.—The only company reporting pyrites production in Wisconsin in 1934 was the Vinegar Hill Zinc Co. in Grant County, which makes a pyrites concentrate at its magnetic separation plant at Cuba City from raw zinc concentrates obtained from several mines in the Platteville district.

FOREIGN TRADE

Imports of pyrites amounted to 366,315 long tons in 1934 compared with 374,417 tons in 1933. These figures may not be strictly comparable owing to the change in reporting statistics from "general imports" in 1933 and earlier years to "imports for consumption" in 1934, although in general this change has little effect on the figures for nondutiable commodities such as pyrites. There were no exports in 1933 or 1934.

The following table shows imports from 1930 to 1934, by countries of origin.

Pyrites, containing more than 25 percent sulphur, imported into the United States, 1930–34, by sources [1]

Country	1930		1931		1932		1933		1934	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Canada	42,117	$145,645	24,245	$109,440	12,070	$53,618	29,970	$131,940	19,341	$83,086
Spain	325,992	891,352	327,771	1,386,457	241,178	637,526	341,878	995,551	346,974	1,162,574
U. S. S. R. (Russia)	5	20	50	300			2,569	4,646		
	368,114	1,037,017	352,066	1,496,197	253,248	691,144	374,417	1,132,137	366,315	1,245,660

[1] Data on total imports during 1934 may not be strictly comparable with figures for previous years owing to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

The customs districts into which pyrites has been imported during the last 5 years are shown in the following table.

Pyrites, containing more than 25 percent sulphur, imported into the United States, 1930–34, by customs districts, in long tons [1]

Customs district	1930	1931	1932	1933	1934
Buffalo	90	114			44
Georgia	5,554	5,628		4,006	3,530
Maryland	175,611	125,559	100,434	136,113	162,183
New York	42,145	55,225	33,596	54,536	46,358
Ohio					12,668
Philadelphia	87,178	128,650	95,640	135,392	116,361
San Francisco	7,990				
South Carolina	7,322	5,053	4,008	6,700	11,541
Vermont	19,591	24,131	12,070	28,446	6,629
Virginia	8,187	7,706	7,500	7,700	7,001
Washington	14,446			1,524	
	368,114	352,066	253,248	374,417	366,315

[1] See footnote to preceding table.

Considering the recoverable sulphur content of the imported pyrites as 45 percent, the quantity of sulphur available in imported pyrites in 1934 was approximately 165,000 long tons.

WORLD PRODUCTION

The following table shows world production of pyrites and the quantity of sulphur it is supposed to replace in the market. Most of the figures are taken from official sources of the countries concerned, supplemented by information from publications of the Imperial Institute and other reliable sources.

World production of pyrites (including cupreous pyrites), 1932–34, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1932		1933		1934	
	Gross weight	Sulphur content	Gross weight	Sulphur content	Gross weight	Sulphur content
Algeria	21,159	9,733	16,090	7,401	13,600	6,270
Australia (Tasmania)	278	(2)	1,522	(2)	(2)	(2)
Canada	47,210	23,547	53,164	25,563	10,040	4,990
Chosen	7,130	(2)	14,518	(2)	(2)	(2)
Cyprus [3]	180,481	90,240	213,340	10,667	(2)	(2)
Czechoslovakia	15,640	6,569	15,426	(2)	(2)	(2)
Finland	(2)	(2)	37,798	16,612	(2)	(2)
France	190,756	88,000	168,422	77,000	(2)	(2)
Germany	175,216	75,344	189,647	81,575	(2)	(2)
Greece	86,767	42,068	(2)	(2)	(2)	(2)
Italy	516,961	237,699	733,001	336,615	(2)	(2)
Japan	726,073	290,429	[4] 852,019	[4] 340,808	(2)	(2)
Norway	727,020	318,990	864,576	382,738	(2)	(2)
Poland	219	96	1,228	540	(2)	(2)
Portugal	237,637	111,699	210,660	100,000	220,869	103,808
Rumania	5,350	(2)	20,450	(2)	(2)	(2)
Southern Rhodesia	272	109	11,080	4,471	11,714	(2)
Spain	2,146,441	901,505	2,223,472	933,858	(2)	(2)
Sweden [5]	71,534	27,963	86,295	33,489	(2)	(2)
Union of South Africa	3,436	(2)	3,664	(2)	15,767	(2)
United Kingdom	1,008	(2)	1,150	(2)	(2)	(2)
United States	192,748	67,498	288,874	109,508	439,466	170,336
Yugoslavia	15,718	6,503	17,710	7,417	(2)	(2)

[1] In addition to countries listed Belgian reports production, but figures are not shown separately.
[2] Data not available.
[3] Exports.
[4] Incomplete. Output of more important mines only.
[5] Exclusive of sulphur content of ore from the Boliden mine which, prior to 1932, was reported as arsenic ore and in 1932 was listed as gold, copper, and arsenic ore.

Spain.—Figures for the production of pyrites in 1934 in Spain, the principal world producer, are not yet available, but the increase in exports indicates that output may have been at a higher rate. Exports of iron pyrites increased from 1,708,468 metric tons in 1933 to 1,820,438 tons in 1934. Exports of cupreous iron pyrites containing 1.5 to 5.0 percent copper but more than 45 percent sulphur increased from 199,490 to 248,698 tons.

Norway.—Production of pyrites is the principal mining industry of Norway, the second largest world producer of this commodity. Although the production figure for 1934 is not available at present, the increase in exports indicates that the record output of 864,500 metric tons in 1933 was exceeded. Production from the largest producer, the Orkla-Grube-Aktiebolag, increased from 480,600 tons in 1933 to about 500,000 in 1934. Exports of pyrites in 1934 totaled 656,784 tons, of which 372,038 tons were cupreous and 284,746 tons poor in copper.

Japan.—The production of pyrites in Japan during recent years has been stimulated by the increased demand for sulphuric acid. Output increased 52 percent from 1931 to 1933, and although figures for 1934 are not yet available it is believed that they maintained the high level of 1933. The entire domestic output of pyrites is consumed locally.

Portugal.—The production of pyrites in Portugal was 220,869 metric tons in 1934 compared with 210,660 tons in 1933. The output comes from the San Domingos mine in the Province of Alemtejo.

Germany.—Although Germany is a large importer of pyrites, it has a significant production within its national boundaries, principally from the Meggen district in southern Westphalia. The Meggen pyrites contains considerable zinc and is low in arsenic. The following is an analysis of the ore:[11]

	Percent
Sulphur	41 –43
Zinc	8 – 9
Iron	34 –36
Arsenic	0. 06– 0. 08
Copper	. 01– . 02
Manganese	. 15– . 30
Lead	. 10– . 40
Cobalt and nickel	. 02– . 03
Lime	1. 40– 1. 50
Magnesia	. 70– . 80
Carbon dioxide	1. 80– 1. 90
Phosphoric acid	Trace.
Bed ore	5 – 6

Pyrites is used in Germany for the manufacture of sulphuric acid and by the sulphite pulp and paper industry. In both industries, sulphur is extracted by roasting, resulting in a high-iron-content sinter which is consumed in the iron industry. The Meggen sinter, however, must be treated to remove its zinc content, amounting to about 10 percent, before it can be utilized for ferrous metallurgy. Because of its zinc content, a considerable part of the Meggen sinter is used in the manufacture of lithopone in conjunction with the barite mined in the same district. Recently, renewed attention has been given to the possibilities of extensive exploitation of pyrites in connection with the present shortage of all raw materials. Experience during the World War demonstrated that in an emergency Germany could produce nearly all its requirements.

Canada.—Production of pyrites in Canada totaled 10,040 metric tons in 1934 compared with 53,164 tons in 1933, a decrease of 81 percent; all came from British Columbia and Quebec in both years. The pyrites in 1934 contained 49.7 percent sulphur and was a little higher in grade than that in 1933.

The output in British Columbia declined from 17,494 metric tons in 1933 to 1,088 tons in 1934. The pyrites in 1934 contained 49.5 percent sulphur and came from the Britannia mill, where a pyrites concentrate is produced in the treatment of ores for the extraction of copper. In addition, 23,668 metric tons of auriferous pyrite concentrate was shipped for fluxing purposes; this ore contains some copper, and no settlement was made for sulphur. The auriferous pyrite concentrate went to the Tacoma smelter.

Quebec's output decreased from 35,670 metric tons in 1933 to 8,952 tons in 1934. Production in 1934 came from the Eustis mine of the Consolidated Copper & Sulphur Co. and from the Aldermac mine in Rouyn Township. At both mines pyrites is produced as a flotation concentrate in the treatment of ore which also yields a copper concentrate. The sulphur content of the Quebec production in 1934 was 50 percent. In addition, a considerable tonnage of pyrite was produced and stored.

Canada has an important production of sulphur in the form of sulphuric acid from smelter gases. In 1934 about 41,800 metric tons of sulphur were recovered as acid manufactured from smelter gases at Copper Cliff, Ontario, and at Trail, British Columbia. Elemental sulphur is also being recovered from smelter gases at Trail.

[11] Metallgesellschaft, The "Sachtleben" Aktiengesellschaft für Bergbau und chemische Industrie: Cologne, no. 9, September 1934, pp. 3–11.

SALT, BROMINE, CALCIUM CHLORIDE, AND IODINE [1]

By A. T. Coons

SUMMARY OUTLINE

SALT

Salt produced for sale or use by operators of salt mines, wells, and ponds in the United States in 1934 totaled 7,612,074 short tons, slightly more than in 1933, 11 percent less than the peak production of 8,543,560 tons in 1929 and 19 percent more than the low level of 6,407,973 tons in 1932. Although salt production is classed as a minor industry in the United States the use of salt as a necessary domestic commodity and its importance in industrial and chemical industries have contributed to a relative stability of demand during the past 5 years of business depression.

The total output of salt in the United States in 1934 was 7,612,074 short tons valued at $22,850,797 compared with 7,604,972 tons valued at $22,318,086 in 1933, an increase of 0.1 percent in quantity and 2 percent in value. The average value in 1934 was $3 a ton, 7 cents more than in 1933. The output of evaporated salt and the salt content of brine decreased in 1934 and the output of rock salt increased.

Seventy-three plants (61 companies) reported operation in 1934 compared with 74 plants (57 companies) in 1933.

Salt sold or used by producers in the United States, 1930–34

Year	Short tons				Value [1]	
	Manufactured (evaporated)	In brine	Rock salt	Total	Total	Average
1930	2,358,610	3,718,460	1,977,370	8,054,440	$25,009,480	$3.11
1931	2,203,690	3,300,210	1,854,170	7,358,070	21,541,012	2.93
1932	2,053,421	2,769,821	1,584,731	6,407,973	19,938,830	3.11
1933	2,358,954	3,461,026	1,784,992	7,604,972	22,318,086	2.93
1934	2,281,453	3,417,439	1,913,182	7,612,074	22,850,797	3.00

[1] The values are f. o. b. mine or refinery and do not include cost of cooperage or containers.

[1] Figures on imports and exports compiled by C. Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Figure 113 gives the tonnage and value of salt sold or used by producers, 1925–34.

Figure 114 shows the tonnage of salt sold or used by producers the United States, 1925–34, by classes. The brine salt represents t

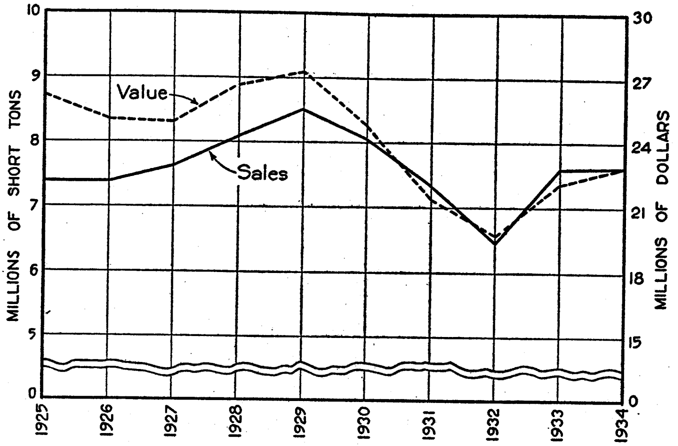

FIGURE 113.—Quantity and value of salt sold or used by producers in the United States, 1925–34.

salt content of brine produced and used in the manufacture of chemicals.

Michigan continued to be the leading salt-producing State, followed by New York, Ohio, Kansas, and Louisiana.

Salt sold or used by producers in the United States, 1932–34, by States

State	1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value
California	281,349	$1,824,021	331,009	$2,018,694	341,893	$2,026,376
Kansas	648,800	2,876,239	732,947	3,039,343	768,133	2,949,930
Louisiana	488,805	2,095,948	532,569	2,345,208	567,289	2,854,785
Michigan	1,715,304	4,845,379	2,090,254	5,679,737	2,012,370	5,470,684
New York	1,556,642	4,785,351	1,847,696	5,120,846	1,866,280	5,263,394
Ohio	1,196,993	2,429,613	1,382,294	2,599,055	1,432,292	2,721,167
Puerto Rico	7,342	13,725	(1)	(1)	(1)	(1)
Texas	139,730	482,118	165,603	560,085	208,979	612,586
Utah	61,230	132,930	56,305	141,330	(1)	(1)
West Virginia	49,629	243,185	63,818	329,051	66,766	384,342
Undistributed [2]	262,149	210,321	402,477	484,737	348,072	567,533
	6,407,973	19,938,830	7,604,972	22,318,086	7,612,074	22,850,797

[1] Included under "Undistributed."
[2] 1932, Nevada, New Mexico, Oklahoma, and Virginia; 1933, Nevada, New Mexico, Oklahoma, Puerto Rico, and Virginia; 1934, Nevada, New Mexico, Oklahoma, Puerto Rico, Utah, and Virginia.

Salt is employed for so large a variety of purposes and marketed so widely throughout the country that satisfactory figures of quantities used annually for even the most common uses have never been compiled. It is possible, however, to show salt production by methods of manufacture, as in the following table.

Salt sold or used by producers in the United States, 1933–34, by methods of manufacture

Method of manufacture	1933		1934	
	Short tons	Value	Short tons	Value
Evaporated in open pans or grainers	573,240	$4,634,344	541,392	$4,410,641
Evaporated in vacuum pans	1,310,676	8,122,608	1,267,157	8,190,797
Solar evaporated	322,368	1,177,718	333,459	1,170,894
Pressed blocks from evaporated salt	152,670	1,129,821	139,445	999,170
Rock	1,754,487	5,401,518	1,883,838	6,139,826
Pressed blocks from rock salt	30,505	168,834	29,344	166,269
Salt in brine (sold or used as such)	3,461,026	1,683,243	3,417,439	1,773,200
	7,604,972	22,318,086	7,612,074	22,850,797

Evaporated salt.—Evaporated salt, produced either from the original brine of wells and ponds or from brine obtained by forcing water into beds of rock salt and withdrawing it for processing, represented 30 percent of the quantity of salt produced in 1934. The output, 2,281,453 short tons valued at $14,771,502, decreased 3 percent in quantity and 2 percent in value compared with 1933. These figures include salt blocks made from evaporated salt and sold mostly for

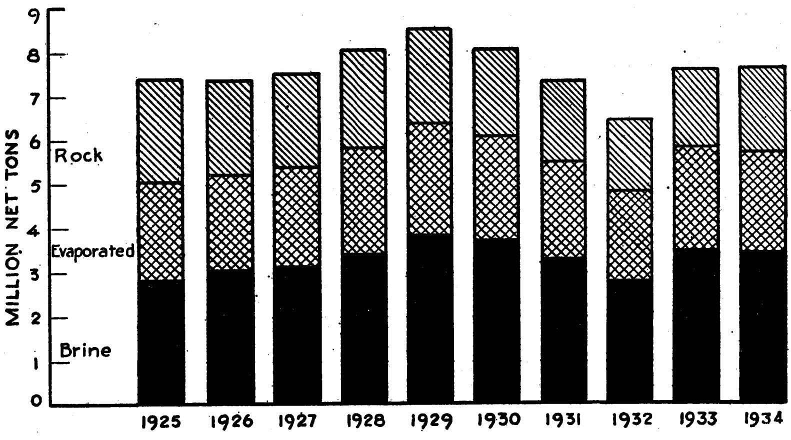

FIGURE 114.—Trends in the quantity of rock salt, evaporated salt, and brine (in terms of salt content) sold or used by producers in the United States, 1925–34.

cattle licks. In 1934 the production of salt blocks amounted to 139,445 short tons valued at $999,170, a decrease of 9 percent in quantity and 12 percent in value from 1933. The average value per ton of all evaporated salt was $6.47, 8 cents more than in 1933. Due to the processing methods applied to this class of salt, the average unit value is higher than that for rock salt.

Michigan retained first rank as a producer of evaporated salt, followed by New York, Ohio, and California, with nearly equal output, and Kansas. In 1934, 40 plants reported sales of salt processed by vacuum-pan or grainer systems, 16 sold solar-evaporated salt, and 19 plants made blocks from evaporated salt.

Evaporated salt sold or used by producers in the United States, 1933–34, by States

State	1933		1934	
	Short tons	Value	Short tons	Value
California	322,728	$1,984,923	333,098	$1,986,964
Kansas	286,436	2,075,914	277,075	1,885,952
Michigan	799,905	4,313,849	722,183	4,023,633
New York	355,956	3,335,367	344,961	3,345,416
Ohio	334,266	2,046,111	333,299	2,135,708
West Virginia [1]	63,818	329,051	66,766	384,342
Undistributed [2]	195,845	979,276	204,071	1,009,487
	2,358,954	15,064,491	2,281,453	14,771,502

[1] Includes a quantity of salt content of brine for chemical use reported as evaporated salt with value as evaporated salt.
[2] Includes Louisiana, New Mexico, Oklahoma, Puerto Rico, Texas, and Utah.

Rock salt.—The output of rock salt in 1934 amounted to 1,913,182 short tons valued at $6,306,095, compared with 1,784,992 tons valued at $5,570,352 in 1933, an increase of 7 percent in quantity and 13 percent in value. The average value of rock salt in 1934 was $3.30 a ton, 18 cents more than in 1933. The figures for rock salt include pressed blocks made from rock salt amounting to 29,344 short tons valued at $166,269, a decrease of 4 percent in quantity and 1.5 percent in value from 1933. Nineteen plants reported production of rock salt in 1934, and eight plants produced blocks. As in 1933, Louisiana, New York, Kansas, and Michigan together produced 92 percent of the rock salt mined. Other States reporting production of rock salt were Texas, California, Utah, and Nevada. On account of the small number of producers of rock salt and salt in brine for chemical manufacture and of rock salt and evaporated salt in certain States, it is impossible to show either rock salt or salt in brine used for chemicals separately, by States, if State totals for all classes of salt are published.

Rock salt sold by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	1,977,370	$6,391,775	1933	1,784,992	$5,570,352
1931	1,854,170	5,735,207	1934	1,913,182	6,306,095
1932	1,584,731	5,100,779			

Salt content of brine.—The quantity of salt in brine sold or used by producers for the manufacture of chemicals in 1934 was 3,417,439 short tons, a decrease of 1 percent from 1933. This class of salt represented 45 percent of the total output and was produced at 8 plants—at Detroit and Wyandotte, Mich. (2 plants); Barberton and Painesville, Ohio; Tully, N. Y.; Corpus Christi, Tex.; and Saltville, Va.

During 1933 and 1934 interest has centered in the Southern States where three large plants for the manufacture of alkalies and allied chemicals have been under construction near the Gulf ports of Baton Rouge and Lake Charles, La., and Corpus Christi, Tex. The salt brine used as the basic raw material will be from deposits owned by the operating companies and located near the plants. The Texas plant started operations in 1934. Short histories of these plants are given in Chemical and Metallurgical Engineering.[2]

[2] Chemical and Metallurgical Engineering, vol. 41, no. 8, August 1934, pp. 408–413.

Pressed blocks.—The production of pressed blocks from both evaporated salt and rock salt reported by the original producers of the salt and shown in the following table does not represent the entire pressed-block industry, as some firms that do not produce salt make pressed blocks from salt bought in the open market. The total production of blocks in 1934 was 168,789 short tons valued at $1,165,439, a decrease of 8 percent in quantity and 10 percent in value from 1933. Eighty-three percent of the blocks were made from evaporated salt, and the output of each class decreased in 1934. Pressed blocks from evaporated salt are made chiefly by salt producers in Kansas and Michigan but are also produced in Texas, Ohio, California, Utah, Oklahoma, and Louisiana. Pressed blocks from rock salt are made chiefly by producers in Louisiana and Kansas, and small amounts are made in Texas and Utah.

Pressed-salt blocks sold by original producers of the salt in the United States, 1930–34

Year	From evaporated salt		From rock salt		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1930	134, 570	$1, 079, 372	42, 150	$234, 353	176, 720	$1, 313, 725
1931	129, 870	983, 652	34, 470	192, 926	164, 340	1, 176, 578
1932	119, 238	848, 194	26, 504	153, 251	145, 742	1, 001, 445
1933	152, 670	1, 129, 821	30, 505	168, 834	183, 175	1, 298, 655
1934	139, 445	999, 170	29, 344	166, 269	168, 789	1, 165, 439

Shipments.—Shipments of evaporated and rock salt in the United States in 1934, given in the following table, was compiled from reports of producers. No account was taken of reshipment beyond the original destination indicated when the salt left the producing plant. The figures contain no salt shipped by jobbers, dealers, or producers shipping salt obtained from other producers.

Shipments of evaporated and rock salt in the United States in 1934, by States, in short tons

Destination	Evaporated	Rock	Destination	Evaporated	Rock
Alabama	7, 293	32, 582	Nevada	2, 322	78
Arizona	7, 605	1, 430	New Hampshire	5, 326	23, 814
Arkansas	12, 709	15, 873	New Jersey	48, 043	65, 630
California	205, 880	9, 481	New Mexico	4, 461	6, 293
Colorado	18, 152	10, 923	New York	162, 809	285, 838
Connecticut	13, 517	5, 343	North Carolina	18, 702	43, 419
Delaware	3, 825	1, 977	North Dakota	11, 691	2, 246
District of Columbia	4, 732	1, 552	Ohio	105, 600	58, 364
Florida	5, 285	20, 441	Oklahoma	28, 438	20, 139
Georgia	11, 957	38, 960	Oregon	23, 713	538
Idaho	10, 072	597	Pennsylvania	98, 814	78, 522
Illinois	202, 176	136, 982	Rhode Island	7, 411	6, 119
Indiana	64, 572	47, 318	South Carolina	3, 942	15, 430
Iowa	61, 758	71, 501	South Dakota	12, 372	10, 859
Kansas	35, 946	148, 606	Tennessee	26, 650	40, 253
Kentucky	26, 249	18, 809	Texas	55, 694	122, 349
Louisiana	6, 201	46, 081	Utah	10, 312	2, 207
Maine	8, 364	15, 932	Vermont	6, 145	1, 279
Maryland	23, 598	20, 260	Virginia	36, 939	13, 163
Massachusetts	56, 399	28, 852	Washington	59, 893	1, 611
Michigan	177, 669	35, 363	West Virginia	66, 049	44, 373
Minnesota	58, 342	55, 851	Wisconsin	83, 964	24, 115
Mississippi	2, 747	31, 178	Wyoming	7, 145	2, 557
Missouri	56, 444	64, 015	Other [1] and undistributed	266, 924	140, 305
Montana	15, 617	2, 195			
Nebraska	30, 985	41, 579	Total sales	2, 281, 453	1, 913, 182

[1] Includes production of Puerto Rico (evaporated salt) and shipments to Alaska, Puerto Rico, and Hawaii and to Australia, British Honduras, Canada, Central America, Japan, Mexico, South America, U. S. S. R. (Russia), West Indies, and countries not specified.

Distribution by uses.—In a report[3] issued in March 1935 the United States Tariff Commission showed the distribution from 1929 to 1933 of dry salt classified as "domestic", "industrial", and "blocks." The results gave supplemental information covering about 91 percent of the total production of rock and evaporated salt combined, as reported by the Bureau of Mines for 1931, 1932, and 1933 and are quoted in part as follows:

The distribution of salt in dry form by the primary producers can be divided somewhat arbitrarily into three major classes which reflect roughly grade, kind of shipping unit, and use. These classes are defined as follows:

1. "Industrial" salt includes all salt, regardless of quality, sold primarily for industrial uses and shipped in bulk, buyer's sacks, or producer's sacks over 50 pounds in size.

2. "Domestic" salt includes all salt sold primarily for domestic and household consumption and shipped in units such as cartons and packages in sizes up to and including 50-pound bags and sacks, together with all barrels. Barrels are included herewith because "packets", or small bags, are generally packed this way and there is now understood to be little shipment of loose salt in barrels.

3. Pressed "blocks", in all sizes, but usually 50–60 pounds. Such blocks are used mostly for cattle lick.

Production of salt in the United States, 1929–33, by classes and forms, in short tons [1]

Year	Industrial				Domestic	Blocks	Total
	Bulk	Buyer's sacks	Producer's sacks	Total			
1929	1,677,257	193,244	650,146	2,520,647	510,525	120,494	3,151,666
1930	1,732,420	187,378	579,485	2,499,283	545,067	109,234	3,153,584
1931	1,912,413	229,566	729,712	2,871,691	691,185	131,210	3,694,086
1932	1,584,500	232,040	656,682	2,473,222	691,828	124,461	3,289,511
1933	1,914,136	245,849	704,471	2,864,456	770,056	172,162	3,806,674
Average	1,764,145	217,615	664,099	2,645,859	641,732	131,512	3,419,103

Year	Bulk forms			Packed forms			Total
	Bulk, buyer's sacks	Blocks	Total	Producer's sacks	Domestic	Total	
1929	1,870,501	120,494	1,990,995	650,146	510,525	1,160,671	3,151,666
1930	1,919,798	109,234	2,029,032	579,485	545,067	1,124,552	3,153,584
1931	2,141,979	131,210	2,273,189	729,712	691,185	1,420,897	3,694,086
1932	1,816,540	124,461	1,941,001	656,682	691,828	1,348,510	3,289,511
1933	2,159,985	172,162	2,332,147	704,471	770,056	1,474,527	3,806,674
Average	1,981,760	131,512	2,113,272	664,099	641,732	1,305,831	3,419,103

[1] Compiled by U. S. Tariff Commission; figures include 82 percent of the total production of rock and evaporated salt reported to the Bureau of Mines from 1929-33, inclusive.

Production of salt in the United States, average for 1929–33, by types, classes, and forms, in short tons [1]

Type	Industrial				Domestic	Blocks	Total
	Bulk	Buyer's sacks	Producer's sacks	Total			
Rock	1,164,633	73,813	221,771	1,460,217	147,571	23,447	1,631,235
Vacuum	311,180	90,498	172,724	574,402	388,324	91,322	1,054,048
Grainer	80,856	53,304	130,807	264,967	91,398	6,515	362,880
Solar	207,476		138,797	346,273	14,439	10,228	370,940
	1,764,145	217,615	664,099	2,645,859	641,732	131,512	3,419,103
Percent of total	51.6	6.4	19.4	77.4	18.8	3.8	100.0

[1] Compiled by U. S. Tariff Commission; figures include 82 percent of the total production of rock and vaporated salt reported to the Bureau of Mines from 1929-33, inclusive.

[3] U. S. Tariff Commission, Production and Distribution of Salt in the United States by Primary Producers: March 1935, 21 pp.

Production of salt in the United States, average for 1929–33, by types, classes, and forms, in short tons—Continued

Type	Bulk forms			Packed forms			Total
	Bulk, buyer's sacks	Blocks	Total	Producer's sacks	Domestic	Total	
Rock	1,238,446	23,447	1,261,893	221,771	147,571	369,342	1,631,235
Vacuum	401,678	91,322	493,000	172,724	388,324	561,048	1,054,048
Grainer	134,160	6,515	140,675	130,807	91,398	222,205	362,880
Solar	207,476	10,228	217,704	138,797	14,439	153,236	370,940
	1,981,760	131,512	2,113,272	664,099	641,732	1,305,831	3,419,103
Percent of total	58.0	3.8	61.8	19.4	18.8	38.2	100.0

Analysis of the production of salt in the United States shows that the output of dry salt has remained exceptionally steady throughout the depression and for the 5-year period (1929–33) that 77 percent of the total output of dry salt was marketed as "industrial" salt, 19 percent as "domestic" salt, and 4 percent as "blocks." The principal producing areas, in order of tonnage of dry salt produced, during this period were New York, Michigan, Kansas, and southern Louisiana. The largest salt market in the United States is that for "industrial" salt in the Northeastern and Northeast Central section. Of all salt of domestic origin entering these two sections, 80.7 percent and 76.8 percent, respectively, was "industrial" salt. Combined, these two sections took about 60 percent of all native "industrial" salt marketed in the United States. These same two sections are likewise the principal markets for "domestic" salt, but the Northeast Central and the Western Central sections comprise the principal market for blocks.

The significance of the distribution as between rock and evaporated salt lies in the fact that rock salt has an average manufactured value about one half that of evaporated salt. Consequently, rock salt is found to predominate in the "industrial" class of salt and evaporated salt in the "domestic" class. Also from a cost-of-marketing standpoint, the percentage of "industrial" salt moving in bulk is important, averaging 51.6 percent of all salt and, when combined with other bulk forms such as buyer's sacks and blocks, amounting to 61.8 percent of all dry salt during the 5-year period from 1929–33.

Code of fair competition.—The provisions of the Code of Fair Competition for the Salt-Producing Industry, as approved on September 7, 1933, were not changed during 1934. An amendment to the code, approved October 26, 1934, allowed the code committee to incorporate under the laws of any State or the District of Columbia. Another amendment, approved December 12, 1934, defined the terms "salt-producing industry", "producer", "employee", and "employer."

According to data compiled by the code committee the salt industry in October 1934 comprised 46 firms having an estimated invested capital of $50,000,000 and employing about 6,400 persons.

LOCALITIES PRODUCING SALT IN THE UNITED STATES IN 1934

The salt deposits in the United States that furnish salt for commercial purposes are, except for small deposits used for local supply, confined to definite regions in the northeastern, south central, and western parts of the country. Michigan, New York, and Ohio, included in the first group, furnished 70 percent of the total salt sold or used by producers in 1934. Kansas and Louisiana, in the central belt of States, are the next largest producers, and California leads the Western States.

The salt is marketed as evaporated salt and as rock salt. Salt brine is drawn from wells by several chemical manufacturers, and the salt content is used by them in their manufacturing processes. Bittern water, or the residues from some of the salt works, is sold to chemical manufacturers for further treatment and for the recovery of bromine and calcium chloride.

Companies reporting to the Bureau of Mines in 1934, the location of their plants, and the nature of the salt sold or used by them are listed by States on the following pages:

California.—In California salt is obtained from sea water, salt springs and lakes, and rock salt. The greater part of the production is from the solar evaporation of sea water, especially along the shores of San Francisco Bay in Alameda and San Mateo Counties. Reports were received in 1934 from the following:

Alameda County:
- Alvarado—Leslie-California Salt Co. (address, 310 Sansome Street, San Francisco); evaporated salt (open pans or grainers, solar, vacuum pans), pressed blocks from evaporated salt.
- Newark—Arden Salt Co. (address, Standard Oil Building, San Francisco); solar evaporation.
- ——— Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (solar, vacuum pans), pressed blocks from evaporated salt. Salt for refining produced by Arden Salt Co.

Imperial County:
- Niland—Imperial Salt Co. (address, 4000 East Washington Street, Los Angeles); evaporated salt (solar). New plant, 1934.
- ——— Mullet Island Chemicals, Inc. (address, Calipatria, Calif.); evaporated salt (open pans or grainers). Operations started in 1934.

Kern County: Fremont and Saltdale (Ceneda)—Long Beach Salt Co. (address, Long Beach); solar evaporation. Fremont plant idle in 1934.

Los Angeles County: Long Beach (Anaheim Road)—Long Beach Salt Co.; solar evaporation.

Modoc County: Cedarville—Surprise Valley Salt Works; solar evaporation.

Monterey County: Moss Landing—Monterey Bay Salt Co.; solar evaporation.

San Bernardino County:
- Amboy (Saltus)—California Rock Salt Co. (address, 2465 Hunter Street, Los Angeles); rock salt, also calcium chloride from Amboy playa.
- ——— Saline Products, Inc. (address, 2000 Santa Fe Avenue, Los Angeles); rock salt, also calcium chloride.
- Rice—Rock Salt Products Co. (address, 845 El Centro Avenue, South Pasadena); rock salt. Operations started in 1934. Refinery located in South Pasadena.
- Westend—Burnham Chemical Co. (address, 6066 Rockridge Boulevard, Oakland); solar evaporation (from Searles Lake deposits).

San Diego County: Chula Vista—Western Salt Co. (address, 1245 National Avenue, San Diego); solar evaporation.

San Mateo County:
- Leslie—Leslie-California Salt Co. (address, 310 Sansome Street, San Francisco); evaporated salt (solar, vacuum pans), pressed blocks from evaporated salt. Idle in 1934.
- Redwood City—Stauffer Chemical Co. (address, 636 California Street, San Francisco); solar evaporation.

A considerable quantity of bitterns or waste water from the salt plants is used by chemical plants in the manufacture of dibromide, magnesium chloride, other magnesium salts, and insulating material. Iodine is extracted from brine obtained from oil wells.

Kansas.—In 1934 Kansas again ranked fourth among the salt-producing States. The salt sold in the State is rock salt and evaporated salt made from brines obtained from solution of rock salt. The companies reporting in 1934 were as follows:

Ellsworth County:
- Kanopolis—Crystal Salt Co. (address, Equitable Building, Denver, Colo.); rock salt.
- ——— Independent Salt Co. (address, 33 South Clark Street, Chicago, Ill.); rock salt.

Harper County: Anthony—The Anthony Salt Co.; evaporated salt (open pans or grainers), pressed blocks from evaporated salt.

Reno County:

Hutchinson—The Barton Salt Co.; evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.

——— The Carey Salt Co. (east plant); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.

——— ——— (rock salt mine); rock salt, pressed blocks from rock salt.

——— Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.

Rice County:

Lyons—American Salt Corporation (address, New York Life Building, Kansas City, Mo.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.

——— Diamond Crystal Salt Co. (address, 250 Park Avenue, New York, N. Y.); evaporated salt (vacuum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.

Louisiana.—Louisiana in 1934 again ranked fifth in quantity of salt produced. Both rock salt and evaporated salt were produced in 1934. The firms reporting in 1934 were:

Iberia Parish:

Avery Island—Avery Salt Co. (address, Scranton, Pa.); evaporated salt (vacuum pans), rock salt.

Jefferson Island—Jefferson Island Salt Mining Co., Inc. (address, Columbia Building, Louisville, Ky.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.

Weeks Island—Myles Salt Co., Ltd. (address, 1048 Constance Street, New Orleans); rock salt, pressed blocks from rock salt.

Winn Parish: Winnfield—The Carey Salt Co. (address, Hutchinson, Kans.); rock salt, pressed blocks from rock salt.

Michigan.—Michigan in 1934 again ranked first among the salt-producing States. The output is obtained from both rock salt and natural brine. In 1934 reports were received from the following companies:

Manistee County:

Manistee—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt, also bromine.

——— Manistee Salt Works (address, 4200 Forest Park Boulevard, St. Louis, Mo.); evaporated salt (open pans or grainers, vacuum pans).

Mason County: Ludington—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt. Plant idle in 1934, sales from stock.

Midland County: Midland—The Dow Chemical Co.; evaporated salt (vacuum pans), also bromine and calcium chloride.

Saginaw County:

Saginaw—Mershon, Eddy, Parker Co.; evaporated salt (open pans or grainers).

——— Saginaw Salt Products Co.; evaporated salt (open pans, or grainers), also calcium chloride.

——— Strable Lumber & Salt Co.; evaporated salt (open pans or grainers).

St. Clair County:

Port Huron—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.

St. Clair—Diamond Crystal Salt Co. (address, 250 Park Avenue, New York, N. Y.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.

Wayne County:
Delray—The Solvay Process Co. (address, Syracuse, N. Y.); brine for the manufacture of chemicals.
Detroit—Detroit Rock Salt Co. (address, Scranton, Pa.); rock salt.
Wyandotte—Michigan Alkali Co.; brine for the manufacture of chemicals.
——— Pennsylvania Salt Manufacturing Co. (address, Widener Building Philadelphia, Pa.); evaporated salt (open pans or grainers), brine for the manufacture of chemicals.

Nevada.—In 1934 the Virgin River Salt Co. produced rock salt at St. Thomas, Clark County.

New Mexico.—Production of solar evaporated salt in 1934 was reported in Torrance County by New Mexico Salt Co., Willard.

New York.—New York in 1934 again ranked second among the salt-producing States. Both evaporated and rock salt are supplied by producers, but the entire product is from rock salt. Brine for evaporated salt is obtained by dissolving the rock salt with water that is allowed to flow into the beds and is pumped out when saturated. The producing companies in 1934 were as follows:

Livingston County:
Retsof—Retsof Mining Co. (address, Scranton, Pa.); rock salt.
Piffard—Worcester Salt Co. (address, 40 Worth Street, New York); evaporated salt (open pans or grainers, vacuum pans).
Onondaga County: Solvay (plant) and Tully (wells)—The Solvay Process Co. (address, Syracuse); evaporated salt (vacuum pans), brine for the manufacture of chemicals with the refined salt as a byproduct.
Schuyler County:
Watkins Glen—International Salt Co. (address, Scranton, Pa.); evaporated salt (open pans or grainers, vacuum pans).
——— The Watkins Salt Co.; evaporated salt (open pans or grainers, vacuum pans).
Tompkins County:
Myers—International Salt Co. (address, Scranton, Pa.); evaporated salt (open pans or grainers, vacuum pans).
——— Cayuga Rock Salt Co., Inc.; rock salt.
Wyoming County: Silver Springs—Worcester Salt Co. (address, 40 Worth Street, New York); evaporated salt (open pans or grainers, vacuum pans.)

Ohio.—Ohio in 1934 again ranked third in production of salt. The larger part of the output is used in the form of brine for the manufacture of chemicals.

Cuyahoga County: Cleveland—The Union Salt Co.; evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.
Lake County: Painesville—Diamond Alkali Co. (address, 436 Seventh Avenue, Pittsburgh, Pa.); evaporated salt (vacuum pans), brine for the manufacture of chemicals.
Meigs County:
Minersville—Pomeroy Salt Corporation (address, Pomeroy); evaporated salt (open pans or grainers), also bromine and calcium chloride.
Pomeroy—The Excelsior Salt Works, Inc.; evaporated salt (open pans or grainers). Bromine and calcium chloride.
Summit County:
Barberton—Pittsburgh Plate Glass Co. (Columbia chemical plant); brine for the manufacture of chemicals.
Kenmore—The Colonial Salt Co. (address, Akron); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.
Wayne County: Rittman—The Ohio Salt Co. (address, Wadsworth); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt.

Oklahoma.—In 1934 the Texaco Salt Products Co. (address, c/o the Texas Co., Houston, Tex.) produced evaporated salt, bromine, and calcium chloride from wells at West Tulsa, Tulsa County. Other salt is taken from playas and lagoons in the State and used locally chiefly as cattle salt. In 1934 Y. L. Stockman reported sales of such salt from near Vinson, Harmon County.

Puerto Rico.—In 1934 two companies reported production, as follows:

Cabo Rojo and Guanica—Puerto Rico Salt Works, Inc. (address, Mayaguez); solar evaporation.

Lajas—Miguel Antonio Ramirez Dominguez (address, San German); solar evaporation.

Texas.—Salt was produced in Texas in 1934 as follows:

Anderson County: Palestine—Palestine Salt & Coal Co.; evaporated salt (open pans or grainers), pressed blocks from evaporated salt.

Harris County: Hockley—United Salt Corporation (address, 425 Cotton Exchange Building, Houston); rock salt.

Nueces County: Corpus Christi—Southern Alakali Corporation (address, Barberton, Ohio); brine for the manufacture of chemicals. Operations started in 1934.

Van Zandt County: Grand Saline—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); evaporated salt (open pans or grainers, vacuum pans), pressed blocks from evaporated salt, rock salt, pressed blocks from rock salt.

Salt formed by the evaporation of the waters of playas and lagoons is also used locally by cattlemen, but there is no record of the quantity so used.

Utah.—Production of salt in Utah in 1934 was reported by the following companies:

Salt Lake County: Saltair—Royal Crystal Salt Co. (address, 133 Regent Street, Salt Lake City); solar evaporation, pressed blocks from evaporated salt.

Sanpete County: Axtell—Royal Crystal Salt Co. (address, 133 Regent Street, Salt Lake City); rock salt.

Sevier County:

Redmond—Great Western Salt Co.; rock salt, pressed blocks from rock salt.

——— Poulsen Bros.; rock salt. Idle in 1934.

Tooele County: Burmester—Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.); solar evaporation, pressed blocks from evaporated salt. Idle in 1934.

Virginia.—Salt brine is produced in Virginia at Saltville, Smyth County, by the Mathieson Alkali Works, Inc., for the manufacture of chemicals.

West Virginia.—The salt made in West Virginia is all obtained from natural brines. In 1934 the operators were as follows:

Kanawha County:

Malden—J. Q. Dickinson & Co.; evaporated salt (open pans or grainers), also bromine and calcium chloride.

South Charleston—Westvaco Chlorine Products, Inc.; brine used in the manufacture of chlorine; also bromine.

Mason County:

Hartford—Liverpool Salt Co.; evaporated salt (open pans or grainers), also bromine and calcium chloride.

Mason—Ohio River Salt Corporation; evaporated salt (open pans or grainers), also bromine and calcium chloride.

FOREIGN TRADE

Imports of salt for consumption in the United States in 1934—53,124 short tons valued at $120,520—increased 76 percent in quantity and 74 percent in value compared with 1933. All classes increased in both quantity and value. The quantity of salt exported in 1934 was slightly higher than in 1933, but the value decreased. Forty-four percent of the salt exported in 1934 went to Canada, 24 percent to Japan, 18 percent to Cuba, and 7 percent to U. S. S. R. (Russia).

Salt imported for consumption in the United States, 1930–34

Year	Used for curing fish		In bags, barrels, and other packages		In bulk		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	25,176	$49,212	5,811	$45,682	23,034	$49,059	54,021	$143,953
1931	16,354	27,042	1,465	21,343	15,397	36,126	33,216	84,511
1932	11,110	14,034	1,728	21,056	15,180	30,955	28,018	66,045
1933	17,424	25,510	1,803	16,566	10,901	27,231	30,128	69,307
1934	31,734	56,662	2,296	19,334	19,094	44,524	53,124	120,520

Salt imported into the United States, 1933–34, by countries [1]

Country	1933		1934	
	Short tons	Value	Short tons	Value
North America:				
Canada	1,498	$5,987	3,657	$10,152
Mexico	54	544	35	300
West Indies:				
British:				
Jamaica	5,439	14,405	4,187	10,950
Other British	7	50	167	418
Netherland	4,196	8,657	2,537	10,822
Virgin Islands of United States			18	186
Europe:				
Germany	2,781	14,043	1,137	7,236
Spain	14,844	19,147	32,003	50,517
Sweden	3	221	1	59
United Kingdom	604	6,995	788	10,089
Asia: China	(2)	15		
Africa:				
Algeria and Tunisia			5,857	10,538
Egypt	11	15	2,227	7,761
Portuguese, "Other"			510	1,492
	29,437	70,079	53,124	120,520

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years, due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.
[2] 510 pounds.

Although the figures for 1933 and 1934 are not strictly comparable, they are sufficiently so to show the sources of the 76-percent increase in salt imported for consumption. Compared with 1933 the imports from Canada more than doubled in 1934, as did those from Spain, and the total imports reported from Africa amounted to 8,594 short tons as against 11 tons in 1933. Imports from Mexico, the West Indies, Germany, and other European countries decreased but those from the United Kingdom increased somewhat.

Salt exported from the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	70,478	$715,575	1933	105,178	$626,694
1931	98,710	775,490	1934	105,365	615,724
1932	63,581	478,435			

Salt exported from the United States, 1933–34, by countries

Country	1933		1934	
	Pounds	Value	Pounds	Value
North America:				
Bermudas	30,439	$510	101,292	$1,087
British Honduras	326,097	2,780	902,072	6,604
Canada	100,523,915	242,430	92,494,652	233,219
Central American States:				
Costa Rica	29,270	382	33,043	472
Guatemala	2,238,440	7,085	379,162	2,669
Honduras	1,675,871	12,825	1,311,724	10,600
Nicaragua	661,679	6,348	675,891	6,392
Panama	1,176,232	9,208	2,048,392	20,519
Salvador	4,280	90	3,798	38
Mexico	1,948,094	14,862	4,789,111	34,498
Miquelon and St. Pierre Islands	1,739	38	560,324	2,014
Newfoundland and Labrador	15,345	354	9,825	206
West Indies:				
British:				
Jamaica	3,559	114	9,626	123
Other British	13,346	281	28,337	696
Cuba	18,179,497	95,308	38,891,517	185,638
Dominican Republic	98,637	1,976	263,857	5,069
Haiti	35,100	818	50,638	1,062
Netherland	106,774	1,159	145,169	1,683
Virgin Islands of the United States	7,863	204	58,932	988
South America:				
Argentina	10,420	375	3,600	84
Bolivia	480	16	39	2
Colombia	28,948	378	36,293	486
Ecuador	80	3		
Guiana:				
British	1,100	110	1,100	110
Surinam (Netherland)			96	3
Uruguay	6,248	162	8,640	209
Venezuela	1,200	20	192	6
Europe:				
Bulgaria	450	10	5,850	150
France	21,718	216	156	6
Germany	1,360	62		
Greece			54,000	530
Irish Free State			10,345	683
Italy			59	1
Netherlands			620	10
Norway			975	35
Sweden	4,875	168	19,560	616
United Kingdom	24,696	325	69,937	2,386
Asia:				
Arabia	84	6	380	15
Ceylon	408	36	488	40
China	20,349	987	28,647	1,173
East Indies:				
British:				
India	6,837	213	3,331	197
Malaya	2,176	51	1,644	39
Netherland	15,345	600	9,814	425
Hong Kong	29,909	1,051	25,573	1,141
Indo-China, French	104	5	580	27
Japan	40,107,665	42,628	51,061,322	43,758
Kwantung	2,664	104	6,936	249
Palestine	195	7	195	6
Philippine Islands	382,623	5,186	427,468	6,997
Siam	48	2	464	29
Syria			48	1
U. S. S. R. (Russia)	40,241,680	149,515	13,912,640	15,446
Other Asia	348	20	216	9
Africa:				
Belgian Congo			256	7
British:				
East			1,053	35
Gold Coast			702	23
Nigeria	25	1	243	7
South (Union of)	1,170	45	5,468	108
Egypt	2,730	99		
Liberia	87	2	1,058	13
Morocco	2,760	55	6,036	191
Portuguese:				
Mozambique	39	2		
Other Portuguese			70	3
Oceania:				
British:				
Australia	1,552,730	17,665	1,351,040	16,336
New Zealand	573,200	6,895	634,982	7,268
Other British	19,653	217	6,600	119
French	214,520	2,685	274,797	3,168
	210,355,101	626,694	210,730,875	615,724

World production of salt, 1929–33, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1929	1930	1931	1932	1933
North America:					
Canada	299,518	242,787	231,885	237,025	262,546
Costa Rica	4,250	3,050	3,000	2,700	2,900
Cuba	14,515	24,947	22,680	31,751	35,000
Guatemala	(2)	7,915	(2)	(2)	(2)
Mexico	79,717	83,787	87,104	81,476	90,730
Nicaragua	(2)	(2)	(2)	(2)	28
Panama	935	366	1,035	6,000	2,604
United States:					
Rock salt	1,916,880	1,793,831	1,682,066	1,437,636	1,619,309
Other salt	5,833,666	5,512,996	4,993,028	4,375,549	5,279,769
West Indies:					
British:					
Bahamas [3]	799	3,193	12,447	254	2,865
Grenada (Windward Islands) [3]	70	155	131	(2)	(2)
Leeward Islands [3]	1,310	1,541	2,353	771	35
Turks and Caicos Islands [3]	62,135	42,208	27,361	20,956	24,960
Netherland [3]	4,677	4,820	6,352	11,502	9,401
South America:					
Argentina [4]	197,799	144,593	159,372	181,138	205,568
Chile	37,422	39,623	(2)	26,000	44,649
Colombia [5]	29,000	29,000	29,000	29,000	29,000
Ecuador:					
Rock salt	69	126	148	-----------	109
Other salt	17,377	24,433	28,858	[5] 28,000	35,428
Peru	30,000	30,000	28,000	(2)	(2)
Venezuela	25,443	20,722	(2)	23,648	(2)
Europe:					
Austria:					
Rock salt	3,041	1,063	862	912	1,075
Other salt	175,442	156,559	122,612	170,570	140,669
Bulgaria:					
Rock salt	3,653	1,704	3,900	3,380	6,000
Other salt	25,194	31,642	40,568	24,040	14,000
Czechoslovakia	166,361	177,693	190,179	177,413	156,565
France:					
Rock salt and salt from springs	1,746,076	1,750,880	1,518,310	1,429,654	1,802,035
Other salt	443,685	248,160	389,340	170,696	(2)
Germany:					
Rock salt	2,541,489	2,455,605	2,086,884	2,115,688	1,841,276
Other salt	501,024	501,258	490,975	485,379	426,297
Greece [5]	100,000	100,000	100,000	100,000	100,000
Italy:					
Rock salt	346,479	332,001	327,174	332,315	344,091
Other salt	563,970	520,099	759,249	599,810	709,413
Malta	482	587	859	880	838
Netherlands: Rock salt [6]	44,914	49,807	56,141	60,765	64,949
Poland	569,488	534,260	561,089	491,508	449,492
Portugal [3]	15,317	27,236	17,010	55,049	55,315
Rumania:					
Rock salt	318,802	304,877	254,808	288,070	281,131
Other salt	2,698	2,155	-----------	-----------	(2)
Spain:					
Rock salt	164,837	164,532	155,448	152,683	156,756
Other salt	914,639	872,966	733,860	806,518	772,460
Switzerland	88,111	82,934	87,727	82,692	83,900
United Kingdom:					
Great Britain:					
Rock salt	28,786	21,377	18,134	17,156	19,835
Other salt	1,962,024	2,066,386	1,897,376	2,223,141	2,370,766
Ireland, Northern:					
Rock salt	7,954	4,048	3,764	2,725	2,107
Other salt	7,093	8,938	(2)	8,747	9,412
Yugoslavia	44,564	54,636	52,745	52,846	45,115
Asia:					
Ceylon	25,482	9,686	45,539	17,987	8,354
China (including Kwantung) [5]	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Chosen	138,000	(2)	(2)	(2)	242,400
Cyprus [5]	3,000	3,000	3,000	3,000	3,000

[1] In addition to the countries listed salt is produced in Bolivia, Brazil, Gold Coast, Madagascar, and Southern Rhodesia, but figures of production are not available.
[2] Data not available.
[3] Exports.
[4] Railway shipments.
[5] Estimated annual production.
[6] Sales.

World production of salt, 1929–33, in metric tons—Continued

Country	1929	1930	1931	1932	1933
Asia—Continued.					
India:					
British (including Aden):					
Rock salt	181, 164	178, 283	164, 491	174, 804	172, 895
Other salt	1, 555, 367	1, 560, 532	1, 704, 431	1, 466, 911	1, 566, 973
Netherland India	514, 106	344, 859	244, 080	236, 283	(2)
Portuguese [5]	12, 000	12, 000	12, 000	12, 000	12, 000
Indo-China [3]	25, 636	42, 471	32, 880	28, 683	69, 421
Iraq [7]	7, 803	8, 919	7, 299	3, 336	(2)
Japan:					
Japan proper [8]	644, 151	628, 682	521, 125	572, 497	(2)
Taiwan	164, 357	163, 217	199, 049	122, 110	(2)
Palestine:					
Rock salt	2, 508	1, 395	1, 259	979	(2)
Other salt	5, 233	6, 102	7, 594	8, 046	8, 404
Philippine Islands	46, 876	40, 572	42, 570	(2)	(2)
Siam	[9] 177, 070	[9] 181, 003	[9] 196, 400	(2)	(2)
Syria [5]	10, 000	10, 000	10, 000	10, 000	10, 000
Turkey [5]	100, 000	100, 000	100, 000	100, 000	100, 000
Africa:					
Algeria	15, 305	58, 443	36, 161	57, 605	78, 878
Belgian Congo [5]	80	80	80	80	80
Canary Islands [5]	2, 000	2, 000	2, 000	2, 000	2, 000
Cape Verde Islands	10, 490	12, 396	11, 075	(2)	(2)
Egypt [3]	149, 023	154, 852	102, 873	142, 097	136, 260
Eritrea	115, 000	123, 083	80, 000	128, 000	92, 497
Ethiopia: Rock salt	10, 000	10, 000	20, 000	25, 000	10, 000
French West Africa	4, 000	2, 200	6, 000	1, 600	(2)
Kenya Colony	(2)	(2)	(2)	194	(2)
Libia (Italian Africa):					
Cyrenaica [5]	10, 000	10, 000	10, 000	10, 000	10, 000
Tripolitania [5]	20, 000	20, 000	20, 000	20, 000	20, 000
Mauritius [5]	1, 500	1, 500	1, 500	1, 500	1, 500
Morocco, French	8, 000	8, 000	8, 000	8, 000	8, 000
Nigeria [5]	400	400	400	400	400
Portuguese West Africa (Angola)[5]	9, 000	9, 000	9, 000	9, 000	9, 000
Somaliland:					
British [5]	15, 000	15, 000	15, 000	15, 000	15, 000
French	38, 972	25, 369	14, 000	30, 792	(2)
Italian	4, 347	77, 970	240, 000	159, 100	150, 000
South-West Africa: Rock salt	334	511	1, 093	2, 102	3, 144
Sudan, Anglo-Egyptian	14, 951	14, 308	11, 437	(2)	(2)
Tanganyika Territory	7, 387	6, 664	6, 845	6, 255	5, 845
Tunisia	120, 165	120, 345	(2)	(2)	86, 511
Uganda	2, 280	1, 779	1, 908	(2)	(2)
Union of South Africa	[10] 88, 857	[10] 89, 338	(2)	62, 092	(2)
Oceania:					
Australia:					
Northern Territory (North Australia)	------------	120	(2)	(2)	(2)
South Australia	77, 684	59, 709	69, 768	61, 027	59, 527
Victoria [5]	50, 000	50, 000	50, 000	50, 000	50, 000
Western Australia [5]	8, 000	8, 000	4, 001	2, 815	(2)

[2] Data not available.
[3] Exports.
[5] Estimated annual production.
[7] Salt issued by the Government for sale.
[8] Year ended Mar. 31 of year following that stated. The figures do not include output from salt beds which, though situated on Government beach lands, have no fixed areas.
[9] Year ended Mar. 31 of year following that stated.
[10] Year ended June 30.

BROMINE

The figures for bromine production in this report comprise the quantity of bromine recovered by the producers from natural brines and the bromine content of bitterns used by producers in the manufacture of bromine compounds. The larger part of the bromine output reported is not sold as bromine but as ethylene dibromide, potassium and sodium bromide, and other bromine compounds. In 1934 the bromine produced amounted to 15,344,290 pounds valued at $3,227,425, an increase of 51 percent in quantity and 58 percent in value over 1933.

Bromine and bromine in compounds sold or used by producers in the United States, 1930–34

Year	Pounds	Value	Year	Pounds	Value
1930	8,462,800	$2,109,974	1933	10,147,960	$2,040,352
1931	8,935,330	1,854,650	1934	15,344,290	3,227,425
1932	5,727,561	1,182,569			

In 1933 a plant was erected near Wilmington, N. C., by the Ethyl-Dow Chemical Co. (address, 40 East Forty-second Street, New York, N. Y.) for the direct extraction of bromine from sea water. The first commercial output was in 1934 and accounted for a large part of the increased production. A description of this plant and the process used in the extraction of bromine is described in Industrial and Engineering Chemistry.[4]

In addition to the Ethyl-Dow Chemical Co. the companies that produced bromine in 1934 were: The California Chemical Corporation (address, Newark), Chula Vista, Calif.; Morton Salt Co. (address, 208 West Washington Street, Chicago, Ill.), Manistee, Mich.; the Dow Chemical Co., Midland, Mich.; Pomeroy Salt Corporation (address, Pomeroy, Ohio), Minersville, Ohio; the Excelsior Salt Works, Inc. Pomeroy, Ohio; Texaco Salt Products Co. (address, care of the Texas Co., Houston, Tex.), Tulsa, Okla.; J. Q. Dickinson & Co., Malden, W. Va.; Liverpool Salt Co., Hartford, W. Va.; Ohio River Salt Corporation, Mason, W. Va.; and Westvaco Chlorine Products, Inc., South Charleston, W. Va.

The figures for the value of bromine reported to the Bureau of Mines by the producers represent the value of the bromine f. o. b. plant or shipping point.

The average unit value for 1934 was 21 cents compared with 20 cents a pound in 1933. The wholesale price per pound of bulk bromine quoted in the New York market from 1926 to February 1931 was, according to Chemical and Metallurgical Engineering, 45 to 47 cents. The price quoted March 1931 and continuing through 1934 was 36 to 38 cents.

Bromine and bromine compounds imported for consumption in the United States, 1930–34

Product	1930		1931		1932		1933		1934	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Bromine	1,123	$347	25	$24	27	$27				
Ammonium bromide	[1] 7,717	[1] 2,209	220	63	52	10			3,308	$826
Potassium bromide	64,399	16,439	58,411	18,983	37,480	9,039	9,921	$1,813	4,410	1,047
Sodium bromide	20,774	4,991			2,205	453	4,410	744		
Ethylene dibromide	3,023,484	648,455	1,570,840	358,082	950,610	191,991	290,410	55,864	649,987	143,164
Other bromine compounds	21,594	13,378	43,636	23,053	16,153	7,311	4,156	3,410	211	186

[1] June 18 to Dec. 31. Not separately recorded prior to change in tariff.

[4] Stewart, Leroy C., Commercial Extraction of Bromine from Sea Water: Ind. and Eng. Chem., April 1934, pp. 361–369.

Imports of bromine, potassium bromide, and sodium bromide, which at one time represented the chief imports of bromine products, have virtually ceased. The principal bromine compound imported at present is ethylene dibromide used in the manufacture of ethyl gasoline. In 1934 this material was supplied entirely by Germany, as were all other bromine compounds imported. Imports of ethylene dibromide, which were reported separately for the first time in 1928 (283,205 pounds), increased to 3,024,484 pounds in 1930, dropped to 290,410 pounds in 1933, and increased to 649,987 pounds in 1934, notwithstanding an increase of 51 percent in domestic production of bromine in 1934.

CALCIUM CHLORIDE

The calcium chloride reported in the following table occurs as an original constituent of the natural brine produced in connection with the extraction of salt or salt and bromine from mineral raw materials only. A large output of calcium chloride made by manufacturing processes is not included. The calcium chloride reported includes mixed calcium and magnesium chlorides and other salts.

Production in 1934 was reported as 76,719 short tons valued at $1,153,159, an increase of 33 percent in quantity and 29 percent in value over 1933.

Producers in the United States of calcium chloride from natural brines are the California Rock Salt Co. (address, 2465 Hunter Street, Los Angeles), Saltus, Calif.; Saline Products, Inc. (address, 2000 Santa Fe Avenue, Los Angeles), Amboy, Calif. (idle in 1934); The Dow Chemical Co., Midland, Mich.; Saginaw Salt Products Co., Saginaw, Mich.; Pomeroy Salt Corporation (address, Pomeroy, Ohio), Minersville, Ohio; The Excelsior Salt Works, Inc., Pomeroy, Ohio; Texaco Salt Products Co., Tulsa, Okla.; J. Q. Dickinson & Co., Malden, W. Va.; Liverpool Salt Co., Hartford, W. Va.; and Ohio River Salt Corporation, Mason, W. Va.

Calcium (calcium-magnesium) chloride from natural brines sold by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	116,160	$2,207,800	1933	57,813	$893,442
1931	86,156	1,687,166	1934	76,719	1,153,159
1932	66,286	1,163,385			

Calcium chloride imported for consumption in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	6,641	$95,921	1933	3,583	$48,115
1931	4,916	74,546	1934	1,975	26,271
1932	3,569	48,865			

Calcium chloride exported from the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	21,350	$513,577	1933	15,710	$312,308
1931	24,351	566,573	1934	30,715	566,189
1932	17,747	378,130			

IODINE

Until 1932 little naturally occurring iodine had been produced commercially in the United States. During the war there was a small output of iodine from kelp at plants on the Pacific coast which are no longer active. Extensive experimental work during recent years on processes for the extraction of iodine from brines and oil-well waters has resulted in the establishment of three plants recovering iodine from oil-well brines in Los Angeles County, Calif. These plants were operated in 1934 by the Deepwater Chemical Co., Ltd., Compton, Calif.; the General Salt Co., Ltd., Long Beach, Calif.; and the Io-Dow Chemical Co., Midland, Mich. A plant established at Shreveport, La., where the iodine was recovered from salt brine, was abandoned in August 1933. A description of the iodine industry in California was given in Industrial and Engineering Chemistry.[5]

The domestic output in 1934 was 284,604 pounds valued at $342,957, a decrease of 29 percent in quantity and 49 percent in value which was attributed partly to the increasingly large imports of iodine with decreasingly low value and partly to the high cost of domestic production. In 1934 imports of iodine increased 5 percent in quantity but decreased 27 percent in value compared with 1933. The average value per ton of imported iodine was $3.64 in 1930, $2.08 in 1933, and $1.44 in 1934.

Iodine produced in the United States, 1932–34

Year	Pounds	Value
1932	173, 953	$395, 951
1933	401, 525	669, 289
1934	284, 604	342, 957

The United States has imported its supply of iodine chiefly from Chile, where it is obtained as a byproduct of the nitrate plants. Virtually all the iodine enters the United States in crude form, with occasional small shipments of resublimed material. The imports of crude iodine in 1934 comprised 1,479,023 pounds valued at $2,131,961 from Chile and 2,100 pounds valued at $3,018 from Japan. Crude iodine enters free of duty. The resublimed product is subject to a duty of 10 cents a pound under the Tariff Act of 1930; before June 1930 the duty was 20 cents a pound.

Iodine imported for consumption in the United States, 1930–34

Year	Crude		Resublimed		Year	Crude		Resublimed	
	Pounds	Value	Pounds	Value		Pounds	Value	Pounds	Value
1930	493, 587	$1, 797, 754			1933	1, 411, 687	$2, 936, 489	200	$493
1931	278, 713	998, 079			1934	1, 481, 123	2, 134, 979		
1932	631, 669	2, 225, 661	100	$269					

[5] Robertson, G. Ross, New American Iodine Industry: Ind. and Eng. Chem., April 1934, pp. 376–378.

PHOSPHATE ROCK

By Bertrand L. Johnson and B. H. Stoddard

SUMMARY OUTLINE

The phosphate-rock industry of the United States in 1934 continued its recovery from the extreme low levels of 1932, registering marked increases in mined production, shipments, domestic consumption, and exports. Total stocks held by producers at the end of the year increased somewhat, due largely to an increase in Florida which more than balanced the decline in Tennessee. Shipments of Florida land pebble, soft rock, and hard rock all increased over the preceding year, as did also shipments of rock from Tennessee and the Western States. There were no imports of phosphate rock during the year. Total exports increased 20 percent in quantity and 41 percent in value compared with 1933; foreign sales of high-grade hard rock phosphate more than doubled, being larger in 1934 than in any year since 1931.

Salient statistics of the phosphate-rock industry in the United States, 1932–34

	1932		1933		1934	
	Long tons	Value	Long tons	Value	Long tons	Value
Mined	1,739,197	(1)	2,309,269	(1)	2,871,099	(1)
Sold or used by producers:						
Florida:						
Land pebble	[2] 1,402,334	[2] $4,382,344	2,066,900	$6,020,984	2,249,304	$7,466,087
Soft rock	10,063	24,017	16,841	48,802	28,896	86,447
Hard rock	57,579	373,251	52,382	347,324	91,134	523,783
Total, Florida	1,469,976	4,779,612	2,136,123	6,417,110	2,369,334	8,076,317
Tennessee	[3] 193,666	[3] 776,367	[3] 333,946	[3] 1,373,392	[3] 425,952	[3] 1,815,678
Idaho	23,172	103,243	19,751	80,622	37,151	140,397
Montana	20,090	79,271	492	1,238	2,086	7,613
Virginia	(3)	(3)	(3)	(3)	(3)	(3)
Total, United States	1,706,904	5,738,493	2,490,312	7,872,362	2,834,523	10,040,005
Imports	[4] 12,982	[4] 93,847	7,725	72,597		
Exports	613,035	2,795,654	829,059	3,544,377	993,493	5,008,532
Consumption, apparent [5]	1,106,851	(1)	1,668,978	(1)	1,841,030	(1)
Stocks in producers' hands, Dec. 31:						
Florida	923,230	(1)	792,170	(1)	871,990	(1)
Tennessee	[3] 203,580	(1)	[3] 200,330	(1)	165,480	(1)
Other	3,040	(1)	5,970	(1)	6,580	(1)
Total stocks	1,129,850	(1)	998,470	(1)	1,044,050	(1)

[1] No figures available.
[2] Includes small quantity of tailings.
[3] Virginia included with Tennessee.
[4] Includes imports of Russian apatite.
[5] Quantity sold or used by producers plus imports minus exports.

Outstanding features of the domestic phosphate-rock industry for the past 14 years are shown graphically in figure 115. Production and exports for this period reached their maximum in 1930, declined sharply in 1931 and 1932, and in the succeeding years recovered a part of their loss. Imports reached a maximum of 45,812 long tons in 1928 and have declined steadily, none being reported in 1934. Stocks on hand at the end of the calendar year declined to about 500,000 tons in 1925, then rose gradually to over a million tons in 1932 and 1934. In 1932 the stocks on hand at the end of the year exceeded domestic consumption for the preceding 12 months.

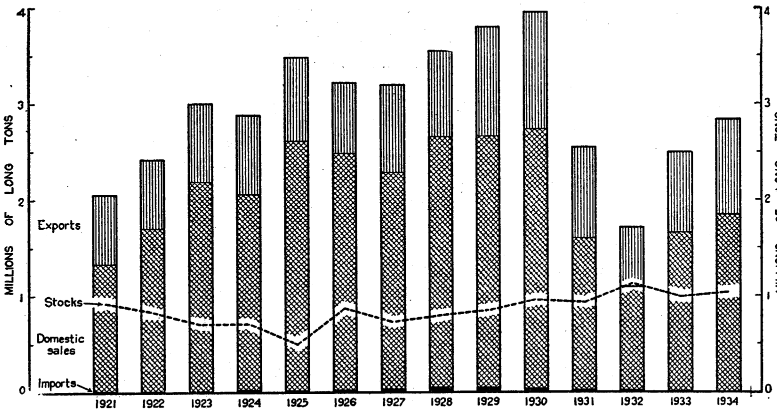

FIGURE 115.—Salient features of the phosphate-rock industry in the United States, 1921–34.

The following general papers covering the phosphate-rock industry of the United States were published in 1934:

JACOB, K. D. Phosphate Rock. Min. Ind., vol. 42, 1934, pp. 441–455.

MARSHALL, H. L. The Occurrence of Ferrous Iron in Phosphate Rock. Jour. Agricultural Research, vol. 49, no. 1, July 1934, pp. 71–76.

McBRIDE, R. S. What and Where are the Process Industries of the South? Chem. and Met. Eng., vol. 41, no. 8, August 1934, pp. 416–423. (Includes a discussion of the phosphate-rock industries of Tennessee and Florida.)

SHUEY, P. McG. Ground Phosphate Rock as a Substitute for Filler in Fertilizer Mixtures. Am. Fertilizer, vol. 80, no. 10, May 19, 1934, pp. 8–9, 26.

——— Ground Phosphate Rock as a Neutralizing Filler. Am. Fertilizer, vol. 81, no. 4, Aug. 25, 1934, pp. 5–6, 24.

Domestic production and sales.—Phosphate rock mined in the United States in 1934 totaled 2,871,099 long tons, an increase of 561,830 long tons (24.3 percent) over 1933 due mainly to an increase of 448,635 tons (22.5 percent) in Florida. Mined production increased about 100,000 long tons (30 percent) in Tennessee and 8,986 tons (51.7 percent) in the Western States. A relatively small quantity of apatite-bearing nelsonite was mined in Virginia. Total sales of phosphate rock in 1934 were greater than in any year since 1930. The quantity sold or used in 1934 was 2,834,523 long tons, an increase of 344,211 tons (13.8 percent) over 1933; the total value was $10,040,005, an increase of $2,167,643 (27.5 percent). The average selling value per ton in 1934 was $3.54 or 38 cents above the 1933 average of $3.16.

Phosphate rock mined in the United States, 1930–34, by States, in long tons

Year	Florida	Tennessee	Western States	Total
1930	3, 261, 539	618, 341	71, 473	3, 951, 353
1931	2, 076, 803	370, 070	130, 662	2, 577, 535
1932	1, 497, 419	[1] 201, 317	40, 461	1, 739, 197
1933	1, 997, 563	[1] 294, 320	17, 386	2, 309, 269
1934	2, 446, 198	[1] 398, 529	26, 372	2, 871, 099

[1] Includes small quantity of apatite from Virginia.

Phosphate rock sold or used by producers in the United States, 1930–34

Year	Long tons	Value	Year	Long tons	Value
1930	3, 926, 392	$13, 996, 830	1933	2, 490, 312	$7, 872, 362
1931	2, 534, 959	9, 288, 485	1934	2, 834, 523	10, 040, 005
1932	1, 706, 904	5, 738, 493			

Shipments of domestic phosphate rock were first shown by grades in 1932. The following table reviews shipments by grades for 1933 and 1934. Data are given for 14 grades, including 4 of outstanding importance: 68 basis, 66 minimum; 70 minimum; 72 minimum; and 75 basis, 74 minimum. These 4 grades constituted 80 percent of the total shipments in 1933 and 85 percent in 1934. Marked increases occurred in shipments of 2 of these grades in 1934—68 basis, 66 minimum and 75 basis, 74 minimum.

Phosphate rock produced in the United States and shipped in 1933–34, by grades, in long tons

B. P. L. content [1] (percent)	1933	1934	B. P. L. content [1] (percent)	1933	1934
Below 60	87, 497	88, 637	75 minimum	87, 323	63, 382
60 to 66	2, 536	18, 321	77 basis, 76 minimum	142, 505	85, 678
68 basis, 66 minimum	507, 188	800, 727	77 minimum	84, 214	97, 709
68 minimum	(2)	(2)	78 basis, 76 minimum	(2)	(2)
69 minimum	(2)	(2)	Above 85 (apatite)	(2)	(2)
70 basis, 69 minimum	(2)	(2)	Undistributed	89, 529	58, 813
70 minimum	562, 982	426, 126			
72 minimum	689, 659	601, 679		2, 490, 312	2, 834, 523
75 basis, 74 minimum	236, 879	593, 451	Total value	$7, 872, 362	$10, 040, 005

[1] Bone phosphate of lime.
[2] Included under "Undistributed"; Bureau of Mines not at liberty to publish figures.

Distribution of sales by uses.—Phosphate rock is used chiefly in the manufacture of superphosphate, but increasing quantities are employed for other purposes. The following figures, compiled from estimates made by the producing companies, indicate the distribution of sales of phosphate rock by major uses in the United States for the past 2 years.

Phosphate rock sold by producers, 1933–34, for consumption in the United States, by major uses, in long tons

Use	1933	1934	Use	1933	1934
Superphosphates	1, 467, 441	1, 561, 066	Fertilizer filler	27, 706	28, 759
Phosphates, phosphoric acid, and ferrophosphorus	243, 823	306, 274	Stock and poultry feed	479	579
Direct application to soil	7, 481	18, 644	Undistributed	2, 286	5, 877
				1, 749, 216	1, 921, 199

Prices.—Prices quoted by the Oil, Paint and Drug Reporter for all grades of phosphate rock remained fairly constant during the first half of the year. On July 1, 1934, new prices were reported which were still in effect December 31, 1934. About midyear sellers of Florida phosphate rock are stated [1] to have abandoned the method of quoting prices in effect since August 1933 and to have stopped quoting for long-term delivery as formerly. There were slight changes in Tennessee prices in April, according to the same journal.

Prices of Florida and Tennessee phosphate rock in 1934, per long ton, f. o. b. mine [1]

Grades of rock (percent)	Jan. 1–June 30	July 1–Dec. 31	Grades of rock (percent)	Jan. 1–June 30	July 1–Dec. 31
Florida land pebble:			Florida hard rock:		
68 minimum	$2.85–$3.20	$3.25	77	$5.90–$6.30	$6.35
70	3.35– 3.70	3.75	Tennessee brown rock:		
72	3.85– 4.20	4.25	72	[2] 5.00	[3] 4.75
75 basis, 74 minimum	4.90– 5.30	5.25	75	[2] 5.50	[3] 5.75
75 minimum	5.00– 5.40	5.35			
77 basis, 76 minimum	5.80– 6.20	6.25			

[1] Weekly quotations of Oil, Paint and Drug Reporter for 1934.
[2] Jan. 1–Apr. 15.
[3] Apr. 16–Dec. 31.

Average values of actual shipments of various types of phosphate rock from mines or plants for 1930–34, inclusive, as computed from reports furnished to the Bureau of Mines by the producers, are shown in the following table. In 1934 increases in the average values over those in 1933 were shown for Florida land pebble, Tennessee phosphate rock, and Montana rock.

Average value f. o. b. mine shipping point per long ton of phosphate rock shipped, 1930–34

[From reports of producers]

Year	Florida		Tennessee [1]	Western States			Total
	Hard rock	Land pebble		Idaho	Montana	Wyoming	
1930	$6.33	[2] $3.24	$4.81	$3.91	$4.57	$4.48	$3.98
1931	6.65	3.39	4.50	3.85	4.44	4.50	4.16
1932	6.48	[3] 3.13	3.98	4.46	3.95		4.22
1933	6.63	2.91	4.11	4.08	2.52		4.04
1934	5.75	3.32	4.24	3.78	3.65		3.54

[1] Chiefly brown rock.
[2] Includes soft rock.
[3] Includes small quantity of tailings.

REVIEW BY STATES

Florida.—In Florida, the leading phosphate rock-producing State, phosphate-rock shipments in 1934 increased to 2,369,334 long tons and their value to $8,076,317. Both quantity and value exceeded those of any year since 1930. All divisions of the industry—land pebble, hard rock, and soft rock—improved in both quantity and value of shipments in 1934 over 1933.

[1] Oil, Paint and Drug Reporter, June 25, 1934, p. 48.

The following companies produced land pebble in 1934:

Amalgamated Phosphate Co., 30 Rockefeller Plaza, New York, N. Y. Plant at Brewster.

The American Agricultural Chemical Co., 50 Church Street, New York, N. Y. Plant at Pierce.

Coronet Phosphate Co., 19 Rector Street, New York, N. Y. Plant at Coronet, near Plant City.

International Agricultural Corporation, 61 Broadway, New York, N. Y. Plant at Prairie, near Mulberry.

The Phosphate Mining Co., 110 Williams Street, New York, N. Y. Plant at Nichols.

Southern Phosphate Corporation, Baltimore Trust Building, Baltimore, Md. Plant at Ridgewood.

Swift & Co., Fertilizer Works, R. F. D. no. 1, Bartow, Fla. Plant at Agricola.

Only two companies mined hard rock in 1934:

C. & J. Camp, Ocala.

Dunnellon Phosphate Mining Co., Savannah, Ga. Mines near Hernando, Citrus County.

Soft-rock phosphate mining operations were in progress in 1934 in several localities. The Colloidal Phosphate Sales Co., mined soft rock at Dunnellon, and sold its product for direct application to the soil. Connell & Shultz, Inverness, mined and marketed a phosphatic clay from a deposit near Inverness. The Lakeland Phosphate & Fertilizer Co. marketed a dried and pulverized phosphatic sandy clay from Bartow for fertilizer filler. The Loncala Phosphate Co., Ocala, mined and sold soft phosphate from a pit at High Springs, Alachua County, for direct application to the soil.

Florida phosphate rock sold or used by producers, 1930–34

Year	Hard rock			Soft rock		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1930	81,753	$517,229	$6.33	(1)	(1)	(1)
1931	57,224	380,540	6.65	13,436	$65,118	$4.85
1932	57,579	373,251	6.48	10,063	24,017	2.39
1933	52,382	347,324	6.63	[2] 16,841	[2] 48,802	2.90
1934	91,134	523,783	5.75	[2] 28,896	[2] 86,447	2.99

Year	Land pebble			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1930	[1] 3,166,318	[1] $10,273,076	[1] $3.24	3,248,071	$10,790,305	$3.32
1931	1,990,806	6,756,428	3.39	2,061,466	7,202,086	3.49
1932	[3] 1,402,334	[3] 4,382,344	[3] 3.13	1,469,976	4,779,612	3.25
1933	2,066,900	6,020,984	2.91	2,136,123	6,417,110	3.00
1934	2,249,304	7,466,087	3.32	2,369,334	8,076,317	3.41

[1] Soft rock included with land pebble.
[2] Includes material from waste-pond operations.
[3] Includes small quantity of tailings.

Tennessee.—Tennessee, which ranks next to Florida as a phosphate-rock-producing State, in 1934 recovered still further from the low point of 1932. Most of the phosphate rock marketed in 1934 came from the brown-rock fields in Maury, Davidson, Giles, Sumner, Lewis, and Hickman Counties. Some blue rock was shipped from Lewis County and white rock from Perry County.

Tennessee phosphate rock [1] sold or used by producers, 1930–34

Year	Long tons	Value at mines		Year	Long tons	Value at mines	
		Total	Average			Total	Average
1930	611,045	$2,938,525	$4.81	1933 [2]	333,946	$1,373,392	$4.11
1931	343,622	1,545,607	4.50	1934 [2]	425,952	1,815,678	4.26
1932 [2]	193,666	776,367	4.01				

[1] Separate figures for brown rock and blue rock cannot be given without disclosing confidential data regarding blue-rock production.
[2] Includes small quantity of apatite from Virginia.

The larger concerns operating in the Tennessee phosphate fields are the following:

Armour Fertilizer Works, 816 Walton Building, Atlanta, Ga.
Chaffin & Williams, Mountpleasant.
Charleston Mining Co., Inc., 627 East Main Street, Richmond, Va.
Federal Chemical Co., 634 Starks Building, Fourth and Walnut Streets, Louisville, Ky.
Harsh Phosphate Co., R. D. 7, East Station, Nashville.
Hoover & Mason Phosphate Co., 8 South Michigan Avenue, Chicago, Ill.
International Agricultural Corporation, 61 Broadway, New York, N. Y.
Jones & Davis, Mountpleasant.
Kimbro & Worley, Centerville.
Sharp & Hackney, Columbia.
Tennessee Valley Authority, Knoxville.

Tennessee's share of the domestic market for phosphate rock in the post-war years has ranged from 17.5 percent in 1932 to 27.7 percent in 1919. It has increased steadily since 1932 and in 1934 was 23.1 percent.

Ratio of Tennessee output to total domestic consumption of phosphate rock, 1910–14 and 1921–34

Year	Percent	Year	Percent
1910–14 [1]	23.2	1932	17.5
1921–25 [1]	18.9	1933	20.0
1926–30 [1]	21.6	1934	23.1
1931	21.5		

[1] 5-year average.

The Tennessee Valley Authority continued to add to its leased holdings of Tennessee phosphate-bearing lands in 1934. On January 1, 1934, forty-three tracts of phosphate land in Maury, Marshall, Giles, Perry, and Williamson Counties, Tenn., totaling 7,343 acres, were under lease by the Authority. By June 30, 1934 [2] it was holding leases on 76 phosphate-bearing tracts in these counties containing

[2] Tennessee Valley Authority, Annual Report and Appendixes, for the fiscal year ended June 30, 1934: Washington, D. C., 1935, p. 60.

14,596 acres, and on December 31, 1934, it is reported to have held 99 phosphate-rock leases on tracts totaling 15,980 acres.

The first mining operation for phosphate rock for the Tennessee Valley Authority in Tennessee was begun early in 1934 on the "Wheeler tract" in the brown-phosphate-rock region near Southport, Maury County, about 12 miles southeast of Mountpleasant. The first shipment of the hand-mined lump brown phosphate rock was on May 2, 1934, by rail from Mountpleasant to Muscle Shoals, Ala. Brown-phosphate-rock shipments were also made to the Authority from Giles County. Mining of white phosphate rock in Perry County for the Tennessee Valley Authority was begun in July 1934, and the first shipment of this rock was made by barge on the Tennessee River on October 22, 1934. Prospecting was conducted by the Authority on a number of other tracts. The total tonnage of phosphate rock shipped during 1934 to Muscle Shoals from the Tennessee fields was 14,548 tons, of which 12,490 tons were brown rock and 2,058 tons white phosphate rock.

In October 1933 a chemical-engineering laboratory was established by the Tennessee Valley Authority at the University of Tennessee at Knoxville, Tenn. Twenty tons of monocalcium and dicalcium phosphates and magnesium calcium phosphate produced experimentally at this laboratory in a semi works-scale pilot plant were distributed in February 1934 to the agricultural experimental stations of the Tennessee Valley States for testing. In June 1934 the preparation of a building at Nitrate Plant No. 2 at Muscle Shoals for permanent use as a chemical-engineering laboratory was started, and much of the equipment of the laboratory established at the University of Tennessee was being transferred to it at the end of the year.

Remodeling was completed in 1934 of 2 of the 12 electric-carbide furnaces in the cyanamide plant at Muscle Shoals (Nitrate Plant No. 2) into 2 electric phosphate-rock reduction furnaces of approximately 6,000 kilowatts capacity each. One of these furnaces is of the same general type as those in operation at Anniston, Ala., with some modifications. The other is stated to be new in design and construction. One furnace was placed in operation on November 7, 1934, and the other on January 15, 1935.

In March 1934 construction of a commercial-size demonstration plant for the manufacture of plant foods was begun adjacent to Nitrate Plant No. 2 at Muscle Shoals, and on November 14, 1934, the first triple superphosphate was produced, and by the end of the year 1,790 tons of triple superphosphate had been produced.

Under an agreement with the Department of Agriculture, signed October 10, 1933, the 6-ton phosphorus blast furnace of the Bureau of Chemistry and Soils at the Fixed Nitrogen Research Laboratory, American University, Washington, D. C., was made available to the T. V. A. On the same date a contract was signed by the Authority with the Research Corporation of New York City to reconstruct the furnace and operate it experimentally to determine the practicability of constructing a similar furnace of larger size, also to design a blast furnace of the smallest size suitable for a commercial demonstration. The experimental program was completed in the summer of 1934, and a commercial-size blast furnace for the production of elemental phosphorus was designed during the year.

Eckel [3] has described the chief mineral resources and the engineering geology of the region tributary to the dams and power plants of the T. V. A., and Henry [4] has given some details regarding the developments at Muscle Shoals.

Virginia.—Apatite concentrates, a coproduct with ilmenite from nelsonite, were converted into monocalcium phosphate by the Southern Mineral Products Corporation at Piney River in Nelson County.

Western States.—Although only two phosphate-rock-producing companies were operating in the Western States in 1934, one in Idaho and the other in Montana, the quantity and value of phosphate rock marketed in each State were greater than in 1933.

Idaho was the larger producing State, and its output of 37,151 tons was nearly double that of the previous year. The production came entirely from the Conda No. 1 mine of the Anaconda Copper Mining Co., Conda, Caribou County. Most of the phosphate rock marketed was converted to treble superphosphate and phosphoric acid in the company's plant at Anaconda, Mont. A small quantity was sold for direct application to the soil.

In Montana the Montana Phosphate Products Co., Garrison, Powell County, Mont., reported operation in 1934 of the Anderson mine and the shipment of 2,133 long tons run-of-mine phosphate rock (2,086 long tons, dry basis), sold for export to Australia, clearance through the Washington customs district. During the year 827 feet of development work (drifting) were done on the property.[5]

Western States phosphate rock sold or used by producers, 1930–34

Year	Idaho			Montana			Wyoming			Total		
	Long tons	Value at mines		Long tons	Value at mines		Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average		Total	Average		Total	Average
1930	59,932	$234,543	$3.91	6,005	$27,457	$4.57	1,339	$6,000	$4.48	67,276	$268,000	$3.98
1931	60,978	234,781	3.85	67,893	301,511	4.44	1,000	4,500	4.50	129,871	540,792	4.16
1932	23,172	103,243	4.46	20,090	79,271	3.95				43,262	182,514	4.22
1933	19,751	80,622	4.08	492	1,238	2.52				20,243	81,860	4.04
1934	37,151	140,397	3.78	2,086	7,613	3.65				39,237	148,010	3.77

FOREIGN TRADE [6]

Imports.—In recent years relatively small quantities of phosphate rock have been imported into the United States. In 1928 imports of phosphate rock reached a post-war maximum of 45,812 long tons. They have declined steadily since that date, and in 1934 no phosphate rock was imported into this country. The following table shows phosphate-rock imports from 1930 to 1934 by countries of origin:

[3] Eckel, E. C., Engineering Geology and Mineral Resources of the Tennessee Valley Authority Region: Tennessee Valley Authority, Gen. Eng. and Geol. Div., Geol. Bull. 1, Knoxville, Tenn., June 1934, pp. 25.

[4] Henry, S. T., What About the T. V. A. Industrial Program? Chem. and Met. Eng., vol. 41, no. 8, August 1934, pp. 414–415.

[5] The Consolidated Mining & Smelting Co. of Canada, Ltd., Annual Report and Statements for 12 Months Ending Dec. 31, 1934, 42 pp.

[6] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Phosphate rock, crude, imported into the United States, 1930–34, by countries [1]

Country	1930		1931		1932		1933	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Canada	830	$16,278						
Cuba	6,360	72,797						
Germany					25	$160		
Morocco, French	6,000	30,000						
Oceania: French	19,417	257,742	12,985	$161,219	6,300	69,741	5,625	$59,409
U. S. S. R. (Russia)	51	360	511	1,298	[2] 6,607	[2] 23,808		
United Kingdom					50	138		
West Indies: Netherland							2,100	13,188
	32,658	377,177	13,496	162,517	12,982	93,847	7,725	72,597

[1] None reported in 1934.
[2] Apatite.

Phosphatic fertilizers other than phosphate rock imported for consumption in the United States include various bone products, guano, and basic slag. In 1934 the quantity and value of imports of these phosphatic materials were much less than in the 2 preceding years. Imports for 1930 to 1934 are given in the following table:

Phosphatic fertilizers (other than crude phosphate rock) imported for consumption in the United States, 1930–34

Fertilizer	1930		1931		1932		1933		1934	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Bone dust, or animal carbon, and bone ash, fit only for fertilizing	59,680	$1,474,500	48,979	$1,080,348	30,118	$508,802	28,500	$519,982	15,948	$308,873
Guano	40,431	1,655,886	13,849	503,861	24,231	489,992	59,772	1,118,268	16,638	337,136
Slag, basic, ground or unground	3,913	54,463	1,464	15,903	2,189	21,005	863	10,698	131	2,009

Russian apatite.—On January 15, 1934 the United States Tariff Commission issued its findings in the Russian apatite case.[7] It found that the processes disclosed in United States Patents 1547732 and 1795100 (claims 2 and 11), are used in the flotation of apatite in the Union of Soviet Socialist Republics and that the importation of apatite so treated into the United States and the sale thereof constitute unfair methods of competition or unfair acts within the meaning of section 337 of the Tariff Act of 1930. It recommended that the President direct the Secretary of the Treasury to instruct customs officers to exclude from entry into the United States phosphates and apatite floated by the process described in Patent 1547732 until July 27, 1942 and that covered by Patent 1795100 until March 2, 1948, unless produced by licenses under these patents.

The Amtorg Trading Corporation appealed from these findings to the United States Court of Customs and Patent Appeals. This court,[8] on February 25, 1935, reversed the decision of the Tariff Commission, holding that the use of the process in Russia was not unlaw-

[7] For previous history see Minerals Yearbook 1934, p. 958.
[8] Treasury Decisions, Treasury Decision 47583: Vol. 67, no. 12, Mar. 21, 1935, pp. 39–66; 78 Fed. (2d) 826.

ful since the patentees held no Russian patent; that the sale, in the United States, of the product, apatite, itself not being patented in the United States, is not an infringement of the United States process patent, and not being an infringement it does not fall within the language "unfair methods of competition and unfair acts"; that the acts upon which an embargo order may be predicated are only such acts as are unfair within the judicial meaning of the statute; and that the Russian exporter had a perfect right to sell and the American importer had a perfect right to buy the apatite and to resell it in the United States.

A rehearing of the case was requested by the domestic producers, but this was denied by the court on April 8, 1935.

Moroccan phosphate rock.—The question of assessment of antidumping duties on Moroccan rock is still pending. Following the refusal of the United States Supreme Court May 15, 1933 to review the decision of the lower court (289 U. S. 750) in the case of *J. H. Cottman & Co.* v. *United States*, the importers filed a motion in the United States Customs Court that the appeals to reappraisement be dismissed and that the entered values be affirmed without assessment of dumping duty. The Government filed a motion that an order be entered dismissing the appeals and that the values returned by the appraiser as the values for dumping purposes be affirmed. The motion was heard on November 14, 1934, and the appeals were dismissed on November 22, 1934.[9]

A rehearing before the United States Customs Court was denied December 3, 1934.[10]

An application was then filed by the importer in the Third Division of the United States Customs Court for review of the decision of the trial court (Reappraisement Decision 3494). The judgment of the trial court was modified and the case remanded. The Third Division concluded that the lower court erred in dismissing the appeals to reappraisement in these cases, so far as they referred to reappraisement under the Antidumping Act of 1921, and in failing to declare that the original appraisements were void as a matter of law. The judgment of the lower court accordingly was modified to that extent and the cause remanded with instructions to issue judgment setting aside the void appraisements and dismissing the appeals so far as they referred to nonexistent appraisements under the Tariff Act of 1922.[11]

Exports.—In 1934 both the quantity and value of the phosphate rock exported from the United States were greater than in 1933, continuing the upward movement started in that year. Exports were higher than in 1931 but not as high as in 1930. Total exports (993,493 long tons) were 20 percent greater than in 1933 and their value ($5,008,532) 41 percent greater. According to the Phosphate Rock Institute this increase in value was due largely to increased takings of the higher grades and not to any appreciable increase in prices per ton. The average value per ton of the phosphate rock exported increased from $4.28 in 1933 to $5.04 in 1934.

[9] Treasury Decisions, Reappraisement Decision 3494, Nov. 22, 1934: Vol. 66, no. 23, Dec. 6, 1934, pp. 41-43.
[10] Treasury Decisions, Reappraisement Decision 3502: Vol. 66, no. 25, Dec. 20, 1934, p. 65.
[11] Treasury Decisions, Reappraisement Decision 3579: Vol. 67, no. 17, Apr. 25, 1935, pp. 62-72.

Phosphate rock, ground or unground, not acidulated, exported from the United States, 1930–34

Year	Long tons	Value	Year	Long tons	Value
1930	1,225,722	$5,630,547	1933	829,059	$3,544,377
1931	951,305	4,277,070	1934	993,493	5,008,532
1932	613,035	2,795,654			

Exports of land-pebble and other phosphate rock were 895,881 long tons valued at $4,335,632, an increase of 14 percent in quantity and 33 percent in value over 1933. Exports of high-grade hard rock more than doubled, increasing from 42,364 tons valued at $295,152 in 1933 to 97,612 tons valued at $672,900 in 1934, an increase of 130 percent in quantity and 128 percent in value. The following table shows total exports of high-grade hard rock, land-pebble, and other phosphate rock, also shipments of each type of rock to various foreign countries annually for 1930 to 1934.

Phosphate rock, ground or unground, not acidulated, exported from the United States, 1930–34, by countries

HIGH-GRADE HARD ROCK

Country	1930		1931		1932		1933		1934	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Australia	946	$10,406							2,133	$16,471
Belgium	14,930	97,145	17,625	$114,562	7,100	$46,150			5,325	37,275
Canada	2,187	21,237	66,993	359,396	29,469	156,652	977	$7,303	823	8,628
Cuba							97	957		
Germany	15,652	107,539	12,325	83,649	9,590	67,130	24,840	173,092	38,100	266,700
Lithuania	8,400	54,600	4,200	27,300	11,500	80,500	11,000	77,000	7,000	49,000
Netherlands	4,125	28,087	4,150	29,050	1,650	11,550	2,750	19,250	14,600	102,200
Panama	2	43							1	31
Poland and Danzig					2,500	16,250	2,700	17,550		
Sweden	19,750	128,375			4,200	27,300			29,630	192,595
	65,992	447,432	105,293	613,957	66,009	405,532	42,364	295,152	97,612	672,900

LAND PEBBLE AND OTHER

Country	1930 Long tons	1930 Value	1931 Long tons	1931 Value	1932 Long tons	1932 Value	1933 Long tons	1933 Value	1934 Long tons	1934 Value
Belgium	16,705	$85,522	4,403	$16,211			9,764	$39,812	4,986	$30,804
Canada	45,561	303,410	54,519	260,029	18,723	$94,830	14,210	51,102	28,650	164,939
Cuba	9,901	54,449			27	390	62	321	9,409	47,016
Czechoslovakia							2,998	14,540		
Denmark	28,991	126,991	25,006	112,537	21,337	90,483	28,696	116,453	32,013	143,817
Finland									3,500	14,875
France	1,502	4,806			2,197	9,144	2,750	6,875	3,006	15,480
Germany	281,547	1,216,147	172,728	697,167	68,058	311,280	130,446	587,678	140,081	721,643
India (British)	1,403	5,261								
Irish Free State	10,456	44,653	3,300	12,243						
Italy	96,169	464,181	62,327	289,906	65,523	292,173	87,767	384,690	104,158	556,433
Japan	287,372	1,051,927	220,389	830,486	143,446	520,095	157,362	485,527	210,614	867,297
Latvia	4,150	20,211					13,144	64,173		
Lithuania	3,142	8,852								
Mexico	44	725	50	210						
Netherlands	164,562	760,487	166,029	755,876	96,507	436,875	153,130	639,662	158,629	792,600
Norway			402	2,312	300	1,050				
Other British West Indies									5	99
Panama					1	20				
Poland and Danzig	36,999	203,053	12,035	70,237	6,386	33,875	20,418	114,450	34,994	219,081
Spain	64,984	321,162	77,962	366,066	77,696	360,697	73,178	327,715	89,226	412,799
Sweden	52,853	277,052	31,047	175,471	41,325	214,102	63,720	299,836	41,645	188,532
United Kingdom	29,615	114,768	9,201	41,292	2,200	10,120	27,400	108,141	22,693	97,419
Yugoslavia and Albania	23,774	119,458	6,614	33,070	3,300	14,988	1,650	8,250	12,272	62,798
	1,159,730	5,183,115	846,012	3,663,113	547,026	2,390,122	786,695	3,249,225	895,881	4,335,632

Exports of high-grade hard rock phosphate from the different customs districts are shown in the following table. In 1934 most of this type of rock (97 percent) was exported from the Florida district. Exports of high-grade hard rock from the Western States were chiefly through the Washington district (2,133 long tons). No rock was shipped from the Montana-Idaho district to Canada as in recent years.

High-grade hard rock phosphate exported from the United States, 1933–34, by customs districts

Customs district	1933		1934	
	Long tons	Value	Long tons	Value
Buffalo	455	$4,715	823	$8,628
Florida	41,342	287,459	94,655	647,770
Maryland	45	390		
Montana-Idaho	522	2,588		
San Francisco			1	$31
Washington			2,133	16,471
	42,364	$295,152	97,612	672,900

WORLD PRODUCTION

In 1934 the United States was the leading producer of phosphate rock, with Tunisia second and Morocco third. Both the United States and Morocco increased their production over 1933, the United States 14 percent and Morocco 16 percent, while Tunisian production declined 2 percent. The production of Algeria, the remaining French North African phosphate-rock-producing country, likewise declined (9 percent). Russia has become an important producer of phosphates, due largely to its development of the apatite deposits of the Kola Peninsula, and ranked fifth in 1933, its production exceeding that of Algeria.

Reports from countries which in 1933 produced about 82 percent of the total world output indicate that the world production in 1934 rose to about 8,900,000 metric tons, an increase of about 500,000 tons over the previous year.

World production of phosphate rock, 1930–34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1930	1931	1932	1933	1934
Algeria	846,686	564,898	569,571	587,753	532,210
Angaur Island [1]	56,345	60,202	65,609	(2)	(2)
Australia:					
New South Wales	26	96	229	71	(2)
South Australia	----------	523	654	26	(2)
Belgium	40,380	49,100	25,810	25,130	(2)
Canada	[3] 36	----------	1,194	2,008	73
China	[4] 8,000	[4] 8,000	[4] 8,000	(2)	(2)
Christmas Island (Straits Settlements) [5]	121,858	66,906	85,548	92,745	129,780
Egypt	313,478	257,011	349,780	440,632	(2)
Estonia	4,850	4,580	1,133	2,818	(2)
France	159,800	107,980	82,700	(2)	(2)
India (British)	308	[4] 111	123	38	(2)
Indo-China	30,300	12,871	373	----------	(2)
Japan	27,713	21,148	18,707	34,739	(2)
Madagascar	11,150	8,000	7,100	13,100	(2)
Makatea Island [5]	176,075	111,422	120,650	79,045	(2)
Morocco, French [6]	1,779,008	900,731	987,317	1,107,333	1,286,796
Nauru and Ocean Islands [7]	512,265	392,172	438,466	691,168	565,522
Netherland India	1,258	110	2,724	7,946	(2)
Netherland West Indies: Curacao [5]	87,497	80,928	65,407	85,550	100,627
New Caledonia	(2)	(2)	1,000	(2)	(2)
Philippine Islands	(2)	260	830	3,097	(2)
Poland	40,000	(2)	(2)	(2)	(2)
Rumania	1,829	----------	----------	----------	(2)
Seychelles Islands [5]	15,977	4,730	14,213	12,307	(2)
Spain	5,400	7,734	9,980	14,507	(2)
Taiwan	57	122	(2)	(2)	(2)
Tunisia	3,326,000	2,148,000	1,678,000	1,810,000	1,766,000
Union of South Africa	----------	1,906	1,183	1,181	(2)
United States (sold or used by producers)	3,989,411	2,575,645	1,734,300	2,530,282	2,880,017
U. S. S. R. (Russia)	[4] 224,000	[4] 330,000	387,000	687,000	(2)

[1] Exports during fiscal year ended Mar. 31 of year following that stated.
[2] Data not available.
[3] Apatite only.
[4] Estimated. (Imp. Inst., London.)
[5] Exports.
[6] Shipments, including exports as follows: 1930, 1,760,812 tons; 1931, 882,909 tons; 1932, 972,692 tons; 1933, 1,091,174 tons; 1934, 1,275,847 tons.
[7] Exports during fiscal year ended June 30 of year stated.

CODE DEVELOPMENTS

No code was issued in 1934 for the phosphate-rock industry itself. The Code of Fair Competition for the Fertilizer Industry, certain phases of which apply to the phosphate-rock industry,[12] was not changed during the year. Several interpretations of parts of the code were made, however, by the fertilizer recovery committee (the code authority), most of which were stated to have been approved by the N. R. A. The subject of the code interpretations was discussed by Murph.[13]

The administration of the code was described in the Fertilizer Review.[14] The code authority, also called the "fertilizer recovery committee", which administered the fertilizer code, consisted of 36 members, of whom 1 represented the Government and 2 others represented farmers' cooperative organizations. Members of the code authority representing small companies had approximately 60 percent of the voting power, those representing small- and medium-size companies had 68 percent, while those representing large companies who did

[12] Johnson, Bertrand L., and Stoddard, B. H., Phosphate Rock: Minerals Yearbook, 1934, Bureau of Mines, pp. 947–967.
[13] Murph, D. S., Code Interpretations, Explanations, and Opinions: Nat. Fertilizer Assoc., Proc. 10th Ann. Convention, 1934, pp. 99–111.
[14] The Fertilizer Review, What Are the Functions of the Fertilizer Code?: Vol. 10, no. 1, January-February 1935, pp 7, 9.

more than three fourths of the business represented on the code authority had only 32 percent of the voting power. An administrative committee of eight members of the code authority met regularly each month. In addition, the country was divided into 12 zones, in each of which there was an executive committee and a zone secretary.

Compliance with the code was assured by the code trade practice complaints agency, established to handle all complaints of violations of the code other than its labor provisions. This agency was composed of members of the administrative committee of the code authority and of a zone trade practice complaints committee for each of the 12 national zones. These 12 committees received, handled, and disposed of all complaints of violations in their respective zones. Their determinations were final and binding, unless and until reversed or modified by the central trade practice complaints committee, the N. R. A., or a court of competent jurisdiction. The central committee heard and disposed of all complaints brought before it on appeal from a decision of a zone committee or on request by any zone committee.[15]

IMPROVEMENTS IN TECHNOLOGY

Flotation.—Barr[16] has discussed the development of phosphate flotation and the practical application of the flotation process to the Florida land-pebble phosphate and the brown-rock phosphate of Tennessee, giving diagrams and flow sheets of the Florida operations.

Calcination of phosphate rock.—Several papers were published in 1934 and the early part of 1935 on the calcination of phosphate rock for the removal of the fluorine content and the conversion of the insoluble phosphate rock into citrate-soluble form readily available as plant food. Brown, Reid, and Jacob[17] reported the results of greenhouse tests of the actual plant food value of calcined phosphate rock. Reynolds, Jacob, Marshall, and Rader[18] presented the results of a study of the factors affecting the action of water vapor on Florida land-pebble phosphate rock in relation to the volatilization of fluorine and the formation of citrate-soluble phosphate.

Marshall, Reynolds, Jacob, and Rader[19] gave the results of experiments in which various domestic and foreign phosphates were treated by the calcination process.

Kunsman[20] has discussed briefly the calcination process and states that the present information indicates that the process can be carried out in rotary kilns with practices and costs comparable to those involved in the manufacture of portland cement.

Blast-furnace operations.—Kunsman[21] has described briefly the operation of the 5-ton blast furnace operated by the Bureau of Chemistry and Soils of the United States Department of Agriculture, for the production of phosphorus.

[15] Mullally, J. A., Compliance Methods and Policies: Nat. Fertilizer Assoc., Proc. 10th Ann. Convention, 1934, pp. 112–119.
[16] Barr, J. A., Development and Application of Phosphate Flotation: Ind. and Eng. Chem., nd. ed., vol. 26, no. 8, August 1934, pp. 811–815.
[17] Brown, B. E., Reid, F. R., and Jacob, K. D., Fertilizer Value of Phosphate Rock Improved by Treatment with Water Vapor at High Temperatures: Am. Fertilizer, Dec. 29, 1934, 4 pp.
[18] Reynolds, D. S., Jacob, K. D., Marshall, H. L., and Rader, L. F., Jr., Phosphate Fertilizers by Calcination Process—Factors Affecting the Reaction Between Water Vapor and Florida Land-Pebble Phosphate: Ind. and Eng. Chem., ind. ed., vol. 27, no. 1, January 1935, pp. 87–91.
[19] Marshall, H. L., Reynolds, D. S., Jacob, K. D., and Rader, L. F., Jr., Phosphate Fertilizers by Calcination Process—Experiments with Different Phosphates: Ind. and Eng. Chem., ind. ed., vol. 27, no. 2, February 1935, pp. 205–209.
[20] Kunsman, C. H., Progress in Fertilizer Technology: Nat. Fertilizer Assoc., Proc. 10th Ann. Convention, 1934, pp. 15–27.
[21] Kunsman, C. H., work cited, pp. 18–19.

SUPERPHOSPHATES

Salient features of the superphosphate industry of the United States are shown in the following tables:

Summary of statistics for superphosphate industry in the United States, 1932–34, in long tons

	1932	1933	1934
Production: [1]			
Bulk superphosphate 16 percent A. P. A.[2] basis	1,765,971	2,694,870	2,868,016
Base and mixed goods 16 percent A. P. A. only	80,559	117,046	116,533
Shipments: [1]			
Bulk superphosphates, to consumers 16 percent A. P. A. basis	709,074	824,176	829,490
Bulk superphosphates, to others do	840,010	953,880	1,120,367
Base and mixed goods 16 percent A. P. A. only	875,291	1,131,707	1,264,215
Stocks (Dec. 31): [1]			
Bulk superphosphates 16 percent A. P. A. basis	1,076,520	1,089,179	1,159,392
Base and mixed goods 16 percent A. P. A. only	341,727	497,589	567,974
Exports of superphosphates [3]	23,883	35,371	59,150
Imports of superphosphates [3]	21,881	23,705	16,308
Sales of phosphate rock by producers for superphosphate production	858,657	1,467,441	1,561,066

[1] Bureau of Census, Monthly Statistics Superphosphate Industry.
[2] Available phosphoric acid.
[3] Bureau of Foreign and Domestic Commerce.

Superphosphates imported into the United States, 1932–34, by countries [1]

Country	1932		1933		1934	
	Long tons	Value	Long tons	Value	Long tons	Value
Belgium	1,189	$28,131	2,537	$51,878	140	$4,594
Canada	2,475	54,034	3,499	63,878	6,119	98,420
Cuba	3,000	44,662				
France	52	771				
Germany			146	3,631	43	341
Italy			10	227		
Japan	13,880	172,464	12,154	158,126	9,362	131,637
Netherlands	1,172	14,623	5,068	35,496	644	10,548
United Kingdom	113	1,159	291	2,081		
	21,881	315,844	23,705	315,317	16,308	245,540

[1] Data on total imports during 1934 may not be strictly comparable with figures for previous years, due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

Superphosphates (acid phosphates) exported from the United States, 1932–34, by countries

Country	1932		1933		1934	
	Long tons	Value	Long tons	Value	Long tons	Value
British Malaya					26	$600
Canada	20,547	$218,640	28,611	$263,242	42,747	433,346
China			605	10,447	2	90
Colombia					11	528
Costa Rica					5	105
Cuba	3,189	35,998	6,055	55,887	13,606	136,950
Dominican Republic	86	3,523	95	4,307		
Honduras					6	106
Mexico					28	963
Philippine Islands					500	14,660
United Kingdom	56	630			2,213	18,333
Venezuela					4	90
Other	5	105	5	83	2	371
	23,883	258,896	35,371	333,966	59,150	606,142

Hill and Jacob[22] in an article published during the year reported the results of a study of the composition and properties of superphosphate.

BASIC SLAG

Basic slag, a byproduct of the manufacture of basic steel, contains considerable phosphorus in a form readily available as plant food, and it has been utilized as a phosphorus-bearing fertilizer since the early eighties, following the invention of the Thomas and Gilchrist modification of the Bessemer process of steel making in 1878. In European countries, where highly phosphatic iron ores are used in the manufacture of steel in Germany, Belgium, England, Luxemburg, and France, and where basic slag is available in large quantities, it has developed into an important source of phosphorus, competing directly with phosphate rock and superphosphates. In 1928 the European consumption of basic slag (known as "Thomas slag") exceeded 4 million tons, about 58 percent of which was used in Germany.

While the production and consumption of basic slag is confined principally to European countries, some is produced in the United States. No statistics of the domestic production are available, but Brand[23] estimates that possibly 20,000 to 30,000 tons of basic slag are used annually in the United States as a fertilizer material. The supply available is stated to exceed greatly the present demand. The United States production of basic slag comes principally from the Birmingham district of Alabama, where it is produced by the Tennessee Coal, Iron & Railroad Co., a subsidiary of the United States Steel Corporation. Here it is a product of the open-hearth process but is claimed to yield the same results as European basic slag made by the basic Bessemer process. It is ground so that 80 percent passes 100-mesh.

A small quantity of basic slag, declining from 3,998 long tons in 1929 to 131 tons in 1934, has been imported into the United States in recent years.

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[22] Hill, W. L., and Jacob, K. D., Composition and Properties of Superphosphate: Jour. Assoc. Official Agricultural Chemists, August 1934, pp. 487-505.

[23] Brand, C. J. (executive director, Fertilizer Recovery Committee), Basic Slag a Fertilizer Material: Mimeographed brief presented to the N. R. A., Fertilizer Recovery Committee, Washington, D. C., Apr. 2, 1934, 11 pp.

FULLER'S EARTH

By W. W. Adams and R. W. Metcalf

SUMMARY OUTLINE

In 1934, for the fourth consecutive year, the production [1] of fuller's earth in the United States decreased. The decline from 1933, although slight (only 1.7 percent), was notable because it continued a downward trend in the output of a mineral whose production had increased rapidly and almost uninterruptedly for 35 years. The decrease in tonnage was accompanied by an increase of 19 cents per ton in the average price at which the material was sold, and the net result was a slight increase in total value.

The production of fuller's earth in 1934 was 220,264 short tons, valued at $2,085,081, an average of $9.47 per ton. The following table summarizes the principal statistics relating to the industry in 1932, 1933, and 1934.

Salient statistics of the fuller's earth industry in the United States, 1932–34

	1932	1933	1934	Percent of change in 1934 from 1933
Sold or used by producers: [1]				
Short tons	[2] 228,309	[2] 224,152	220,264	−1.7
Value	[2] $2,227,727	[2] $2,080,640	$2,085,081	+.2
Average per ton	[2] $9.76	[2] $9.28	$9.47	+2.0
Distribution of domestic production, by uses:				
Bleaching, clarifying, decolorizing, or filtering—				
Mineral oils:				
Short tons	[2] 208,715	[2] 206,100	201,902	−2.0
Percent of total	[2] 91.4	[2] 92.0	91.7	
Vegetable oils and animal fats:				
Short tons	[2] 17,248	[2] 15,765	16,281	+3.3
Percent of total	[2] 7.6	[2] 7.0	7.4	
Miscellaneous uses:				
Short tons	2,346	2,287	2,081	−9.0
Percent of total	[2] 1.0	[2] 1.0	0.9	
Imports:				
Unwrought or unmanufactured:				
Short tons	96	17	34	+100.0
Value	$991	$260	$406	+56.2
Wrought or manufactured:				
Short tons	3,789	4,078	4,278	+4.9
Value	$32,927	$42,050	$53,145	+26.4
Total imports:				
Short tons	3,885	4,095	4,312	+5.3
Value	$33,967	$42,310	$53,551	+26.6
Exports:				
Short tons	5,074	4,870	6,740	+38.4
Value	$40,149	$38,255	$61,974	+62.0

[1] Does not include untreated bentonite reported as used for filtering purposes.
[2] Record of production in United States, 1932 and 1933, revised to exclude small tonnage of bentonite that had been reported as fuller's earth.

[1] Production in this chapter refers to quantities shipped, delivered, or used by producers.

A total of 16 plants (in 8 States) reported production of fuller's earth in 1934. As in previous years, most of the production came from deposits in Georgia and Florida; in fact, these two States accounted for 67 percent of the total output of the entire country.

Texas producers reported an output that represented increases over 1933 in both quantity and value, but was not sufficient to equal the output and value reported for 1932. The combined output from deposits in Florida and Georgia, the two chief producing States, was slightly less than in 1933 in both quantity and value but was larger than in 1932 in quantity, although slightly less in total value. Production from other States is necessarily combined to avoid publishing confidential information; the combined output from these other States increased in 1934 over 1933 both in quantity and value but did not reach the levels of 1932.

Production of fuller's earth in the United States, 1932–34, by States

State	1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	32	$288	266	$2,028	(1)	(1)
California	100	2,250				
Florida and Georgia	144,922	1,462,794	153,703	1,426,979	148,319	$1,407,380
Nevada	(1)	(1)	5,974	61,571	(1)	(1)
Texas	[2] 36,381	[2] 365,374	[2] 31,893	[2] 308,096	32,763	325,397
Other States [3]	[2] 46,874	[2] 397,021	[2] 32,316	[2] 281,966	39,182	352,304
	[2] 228,309	[2] 2,227,727	[2] 224,152	[2] 2,080,640	220,264	2,085,081

1 Included under "Other States."
2 Revised figures.
3 1932: Colorado, Illinois, Massachusetts, and Nevada; 1933: Colorado and Illinois; 1934: Alabama, Colorado, Illinois, Indiana, and Nevada.

Definition.—Fuller's earth is a mineral substance resembling clay, with physical properties that give it a high capacity for removing basic colors from solution in mineral, vegetable, or animal oils. The name does not imply any particular chemical composition but was derived from the use to which the earth was formerly put by fullers to full or scour and cleanse cloth of grease and by furriers to remove grease from fur. For statistical purposes the Bureau of Mines classes as fuller's earth all natural bleaching or filtering claylike materials that have high adsorptive capacity without previous chemical treatment for activation.

Uses.—More than 99 percent of the fuller's earth produced in the United States in 1934 was used to clarify mineral and vegetable oils and animal fats. During the 8 years (1927–34) for which annual records are available the proportion used for clarifying mineral oils has ranged from 90.1 to 97.1 percent of the total production of the entire country. During the same period 2.5 to 8.5 percent of the total output was used in treating vegetable oils and animal fats. Miscellaneous uses have accounted for 0.4 to 2.3 percent of the quantity produced each year. The actual amounts so used, with corresponding values, are shown in the following table:

Fuller's earth sold or used by producers in the United States, 1927–34, by uses

Year	Bleaching, clarifying, decolorizing, or filtering—				Other uses		Total	
	Mineral oils		Vegetable oils and animal fats					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1927	243,009	(1)	15,363	(1)	6,106	(1)	264,478	$3,767,038
1928	258,645	$3,579,273	24,288	$277,197	4,079	$39,521	287,012	3,895,991
1929	301,607	4,164,093	10,685	112,902	3,691	32,728	315,983	4,309,723
1930	326,087	4,220,751	8,312	93,367	1,245	12,587	335,644	4,326,705
1931	272,177	2,883,074	14,133	159,073	2,090	13,423	288,400	3,055,570
1932	[2] 208,715	[2] 2,034,955	[2] 17,248	[2] 177,016	2,346	15,756	[2] 228,309	[2] 2,227,727
1933	[2] 206,100	[2] 1,896,501	[2] 15,765	[2] 169,186	2,287	14,953	[2] 224,152	[2] 2,080,640
1934	201,902	1,894,140	16,281	176,611	2,081	14,330	220,264	2,085,081
	PERCENT OF TOTAL							
1927	91.9	(1)	5.8	(1)	2.3	(1)	100	100
1928	90.1	91.9	8.5	7.1	1.4	1.0	100	100
1929	95.4	96.6	3.4	2.6	1.2	.8	100	100
1930	97.1	97.5	2.5	2.2	.4	.3	100	100
1931	94.4	94.4	4.9	5.2	.7	.4	100	100
1932 [2]	91.4	91.4	7.6	7.9	1.0	.7	100	100
1933 [2]	92.0	91.2	7.0	8.1	1.0	.7	100	100
1934	91.7	90.8	7.4	8.5	.9	.7	100	100

[1] Figures not available.
[2] Revised figures.

Long-time trends.—The annual production of fuller's earth in the United States since 1895 was summarized in Minerals Yearbook, 1934, page 971. These data are shown graphically in figure 116. From an output of 6,900 tons in 1895, production had more than trebled by 1905 and by 1915 had grown to 48,000 tons, or nearly 7 times the output reported 20 years before. Production climbed to 207,000 tons in 1925 and reached an all-time high in 1930 with an output of 336,000 tons, more than 48 times the output in 1895. In the 4 years since 1930 there has been a decline in output, which in 1931 and 1932 was severe but in 1933 and 1934 was almost negligible.

Code of fair competition.—A code of fair competition for the fuller's earth producing and marketing industry, prepared in accordance with the National Industrial Recovery Act, was approved by the National Recovery Administrator on March 23, 1934, and became effective on March 30. The principal provisions of the code were summarized in the chapter on fuller's earth published in Minerals Yearbook, 1934, page 972.

No amendments to the code were made in 1934, and no special incidents in connection with its administration were reported. After the close of the year, the code authority for the industry submitted to the National Recovery Administration a list of occupations in which the employment of persons under 18 years of age should be forbidden as being hazardous or detrimental to health. The list as submitted became effective May 12, 1935, as sufficient cause to the contrary was not shown. The list prohibited the employment of persons under 18 years of age in the following classes of work; (1) Work in or about mines or pits, including all surface work; (2) transportation or use of explosives or explosive substances; (3) all dredging work or hydraulic mining; (4) all work on screens or crushers; (5) oiling, cleaning, or wiping machinery in motion; (6) applying belts to a pully in motion or assisting therein; (7) proximity to any unguarded belt or gearing; (8) work of employees engaged as firemen; (9) switching and work on and about railroad equipment; (10) clean-up on barges or cars under clam-shell buckets; and (11) drivers of trucks or other motor vehicles, or helpers or delivery boys on motor vehicles.

REVIEW BY STATES

Alabama.—A small quantity of fuller's earth was produced in 1934 in De Kalb County, Ala., a section of the State that had not reported production since 1924. From 1925 to 1931 Alabama produced no

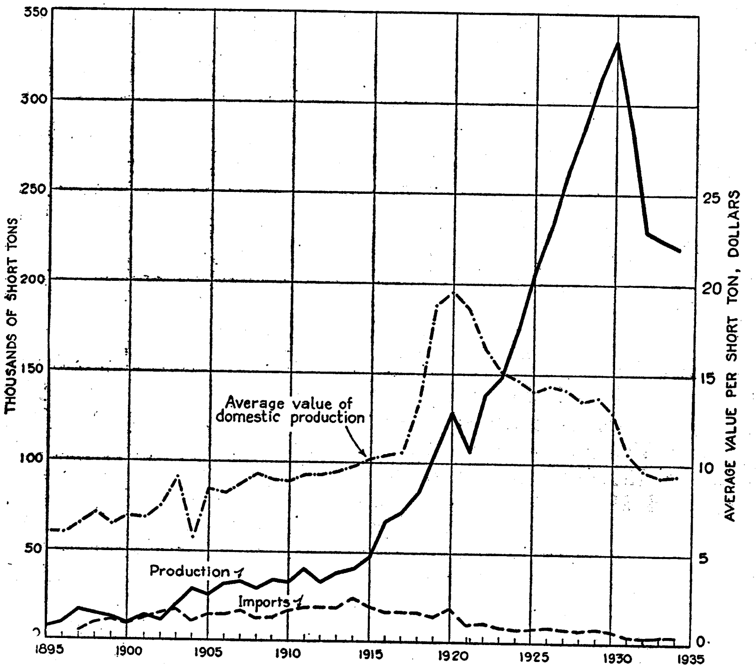

FIGURE 116.—Trends in production, imports, and average value per short ton of fuller's earth, 1895–1934.

fuller's earth. The State reappeared as a producer in 1932; in both 1932 and 1933 the entire output was from Barbour County.

Colorado.—Mineral County accounted for the entire output of fuller's earth in Colorado in 1934, as in 1933. Colorado first became a producer of fuller's earth in 1897 and continued production with but one interruption through 1914. Then followed a period of no output until 1928; since then the State has continued to produce regularly through 1934.

Florida.—From 1895 through 1934 Florida has been a consistent and important producer of fuller's earth. Florida led in production until 1924; since then it has ranked second to Georgia. The output of the State in 1934 was from Gadsden and Marion Counties.

Georgia.—Georgia led in the production of fuller's earth in 1934 with production from Decatur, Twiggs, and Wilkinson Counties.

The leading position as a producer of fuller's earth, which Georgia gained from Florida in 1924, has been consistently maintained.

Illinois.—Illinois first produced fuller's earth in 1922 and has continued as an important and regular producer since that year. The output in 1934, as in other recent years, was entirely from deposits in Pulaski County.

Indiana.—Indiana entered the list of States producing fuller's earth for the first time in 1934. The output for the year was from Floyd County.

Nevada.—Lyon and Nye Counties accounted for all of the fuller's earth mined in Nevada in 1934. Production during 1933 was from Nye County alone. Nevada has been a regular producer since 1924; prior to 1924, production had been reported in 1918 and 1920.

Texas.—All fuller's earth produced in Texas in 1934 was from deposits in Fayette and Walker Counties.

FOREIGN TRADE [2]

Imports.—The United Kingdom supplied virtually all—4,311 short tons—of the fuller's earth imported into the United States during 1934. The rest of the 4,312 tons valued at $53,551 was furnished by Japan and Germany. Total imports increased over each of the 3 preceding years, although imports in 1934 were only about one half of the quantity and one third of the value reported for the last predepression year, 1929. Imports were equivalent to 2 percent of the United States production in 1934.

Fuller's earth imported for consumption in the United States, 1932–34, by countries

	Unwrought or unmanufactured		Wrought or manufactured		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1932						
Germany			24	$738	24	$738
United Kingdom	96	$1,040	3,765	32,189	3,861	33,229
	96	1,040	3,789	32,927	3,885	33,967
1933						
Germany			7	210	7	210
Japan	1	8			1	8
United Kingdom	16	252	4,071	41,840	4,087	42,092
	17	260	4,078	42,050	4,095	42,310
1934						
Germany			(1)	29	(1)	29
Japan			1	7	1	7
United Kingdom	34	406	4,277	53,109	4,311	53,515
	34	406	4,278	53,145	4,312	53,551

1 Less than 1 ton.

2 Figures on imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce; those on exports supplied by the producers. No exports of fuller's earth recorded by the Bureau of Foreign and Domestic Commerce.

Exports.—As exports of fuller's earth are not shown separately in the records of the Bureau of Foreign and Domestic Commerce, information as to the quantity and value of the material exported is obtained annually by the Bureau of Mines from reports furnished directly to the Bureau by the producing companies. Exports in 1934 were 6,740 short tons valued at $61,974. Compared with 1933, shipments to foreign countries in 1934 increased 38 percent in quantity and 62 percent in value. Exports in 1934 also exceeded those in 1932 but did not reach the levels of 1927 to 1931. During the predepression year, 1929, exports of fuller's earth were 21,264 tons valued at $258,408. The chief purchasers of American fuller's earth during 1934 were Canada, Germany, and U. S. S. R. (Russia).

TALC AND GROUND SOAPSTONE [1]

By Alden H. Emery and B. H. Stoddard

SUMMARY OUTLINE

Domestic producers in 1934 sold 138,905 short tons of talc and ground soapstone valued at mine shipping point at $1,450,685 ($10.44 per ton)—10 percent in quantity and 15 percent in value below the average for the 5 years 1930–34. The decrease of about 16 percent in quantity and total value from 1933 represents a partial loss of the 34.7-percent and 27.2-percent gains in quantity and value, respectively, in 1933. Figures for 1932, however, were for talc only and did not include ground soapstone.

The value per ton was practically the same as in 1933. In 1928 the average value of the talc sold was $12.50 per ton; in 1929, $11.96; in 1930, $11.75; in 1931, $11.31; in 1932, $11.05; in 1933, for talc and ground soapstone, $10.43; and in 1934, $10.44.

Talc is sold largely in ground form. Of sales in 1930, only 3 percent was not ground; in 1931, 4.2 percent; in 1932, 4.7 percent; in 1933, 3.8 percent of the talc and ground soapstone; and in 1934, 6.7 percent—an increase due mainly to a 53-percent increase in sales of crude rock.

Talc and ground soapstone sold by producers in the United States, 1930–34, by classes

Year	Crude		Sawed and manufactured		Ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930 [1]	4,972	$48,913	385	$90,370	174,028	$1,969,055	179,385	$2,108,338
1931 [1]	6,673	47,382	181	51,740	156,898	1,753,350	163,752	1,852,472
1932 [1]	5,635	51,657	107	17,749	117,479	1,292,227	123,221	1,361,633
1933	5,985	46,553	[2] 246	[2] 31,686	[2] 159,792	[2] 1,653,643	[2] 166,023	[2] 1,731,882
1934	9,167	57,659	174	46,918	129,564	1,346,108	138,905	1,450,685

[1] Includes talc only.
[2] Revised figures.

[1] The term "ground soapstone" is used in this chapter to include material marketed in the crude form. So far as is known, all of this reaches the consumer as a ground product. Architectural soapstone is included in the chapter on Dimension Stone.

Code of fair competition.—On March 21, 1934, a code of fair competition for the talc and soapstone industry was approved.[2] Members of the code authority during the year were J. Frasier Glenn, Georgia Talc Co., Asheville, N. C.; F. F. Farrar, Cohutta Talc Co., Dalton, Ga.; E. W. Magnus, Eastern Magnesia Talc Co., Burlington, Vt.; W. L. Caten, W. H. Loomis Talc Corporation, Gouverneur, N. Y.; Michael Doyle, International Pulp Co., New York City; nonvoting member, secretary, J. B. Aikman, secretary-treasurer National Association of Talc and Soapstone Producers, Chester, Vt.[3] The code authority reported close and cordial cooperation between the authority, the National Recovery Administration, and industry.

REVIEW BY STATES

The order of importance of the States as producers of talc and ground soapstone was the same in 1934 as in 1933, although large shifts took place in their relative output. A decline of 30 percent in the output in New York State reduced its production from 50 to 41.4 percent of the total. Vermont produced only 5.5 percent less than in 1933 and raised its proportion from 21.8 to 24.7 percent of the total output. California increased its production 3.7 percent in 1934, increasing its proportion from 9.2 to 11.4 percent of the domestic output. North Carolina produced 6.6 percent more talc and ground soapstone in 1934 than in 1933, thus increasing its proportion from 8.7 to 11.1 percent of the total and pressing California for third place. The value of the output in New York, Vermont, California, and North Carolina in 1933 was 56, 17.3, 11.4, and 8.6 percent, respectively, of the total. In 1934 the corresponding figures were 47, 21.6, 11.4, and 11.4 percent.

In 1934 the average value per ton was $11.83 in New York, $10.77 in North Carolina, $10.38 in California, $9.15 in Vermont, and $3.61 in Washington, representing a gain over 1933 for Vermont ($0.88), a large decline for California ($2.48), and no significant change for the other States.

Talc and ground soapstone sold by producers in the United States, 1933–34, by States

State	1933		1934	
	Short tons	Value	Short tons	Value
California	[1] 15,319	[1] $196,972	15,880	$164,777
New York	82,618	969,338	57,580	681,184
North Carolina	[1] 14,412	[1] 149,540	15,367	165,523
Vermont	36,233	299,558	34,243	313,346
Virginia	9,348	40,058	(2)	(2)
Washington	(2)	(2)	900	3,250
Undistributed [3]	[1] 8,093	[1] 76,416	14,935	122,605
	[1] 166,023	[1] 1,731,882	138,905	1,450,685

[1] Revised figures.
[2] Included under "Undistributed."
[3] 1933: Georgia, Maryland, New Jersey, Pennsylvania, and Washington; 1934: Georgia, Maryland, Michigan, New Jersey, Pennsylvania, and Virginia.

[2] National Industrial Recovery Administration, Code of Fair Competition for the Talc and Soapstone Industry, approved code no. 350, registry no. 1039–10, 1934, pp. 287–302.
Rock Products, vol. 37, May 1934, p. 38.
Pit and Quarry, Talc and Soapstone Code approved and in effect: Vol. 26, no. 11, May 1934, p. 17.
[3] Rock Products, vol. 37, August 1934, p. 61.

Producers of talc and soapstone in the United States in 1934

Producer	Material	Product	Location of mine
CALIFORNIA			
Blue Star Mines, Ltd., Bigpine	Talc	Ground	Near Bigpine, Inyo County.
Drake, Davis & Davis, Bigpine	do	Rough	Do.
Glendinning & Co., 1031 South Broadway, Los Angeles.	do	do	Near Darwin, Inyo County.
Frank McDonald, Shingle	Soapstone	do	1¼ miles from Shingle.
W. S. McLean, 1919 San Bruno Avenue, San Francisco.	do	Ground	Butte County.
Pacific Coast Talc Co., 2149 Bay Street, Los Angeles.	Talc	Rough, ground	7 miles north of Silver Lake Station, San Bernardino County.
Pacific Minerals Co., Ltd., 337 Tenth Street, Richmond.	Soapstone	Ground	Shrub, Eldorado County.
Sierra Talc Co., 428 Union League Building, Los Angeles.	Talc	do	Near Darwin, Inyo County.
Western Talc Co., 1901 East Slauson Avenue, Los Angeles.	do	do	Tecopa, Inyo County.
John L. Witney, Inc., Jamestown	Soapstone	Rough	Near Jamestown, Tuolumne County.
GEORGIA			
Cohutta Talc Co., Dalton	Talc	Crayons, ground	Chatsworth, Murray County.
Georgia Talc Co., Asheville, N. C.	do	do	Do.
MARYLAND			
Harford Talc & Quartz Co., 4 Reckford Building, Towson.	Talc, massive steatite, or "lava" grade.	Rough, ground	Near Dublin, Harford County
Maryland Mineral Co., Conowingo	Talc	do	Near Oakwood, Cecil County.
Herbert I. Oursler, Marriottsville	Talc schist	Rough	Near Henryton, Carroll County.
MICHIGAN			
Michigan Talc Mining Co., 514 Morgan Building, Detroit.	Talc	Ground	Ishpeming, Marquette County.
NEW JERSEY			
Jersey Materials Co., 412 Easton Trust Building, Easton, Pa.	Talc and serpentine.	do	Above Marble Hill, on Delaware River near Phillipsburg, Warren County.
NEW YORK			
Carbola Chemical Co., Inc., Natural Bridge.	Talc	do	1¼ miles from Natural Bridge, Lewis County.
International Pulp Co., 41 Park Row, New York.	do	do	Talcville, St. Lawrence County.
W. H. Loomis Talc Corporation, 173 East Main Street, Gouverneur.	do	do	Fowler, St. Lawrence County.
NORTH CAROLINA			
Carolina Talc Co., Murphy	do	Crayons, ground	Near Murphy, Cherokee County.
Standard Mineral Co., Inc., 230 Park Avenue, New York, N. Y.	Pyrophyllite	Ground	2½ miles from Hemp, Moore County.
Talc Mining & Milling Corporation, 178 Whiton Street, Jersey City, N. J.	Talc	do	Glendon, Moore County.
PENNSYLVANIA			
C. K. Williams & Co., 640 North Thirteenth Street, Easton.	Soapstone	Crude	Near Easton, Northampton County.
VERMONT			
Eastern Magnesia Talc Co., Inc., Burlington.	Talc	Crayons, ground	Johnson, Lamoille County, and Waterbury, Washington County.
Vermont Mineral Products, Inc., Chester.	do	Ground	Near Chester, Windsor County.
Vermont Talc Co., Chester	do	do	Windham, Windham County

Producers of talc and soapstone in the United States in 1934—Continued

Producer	Material	Product	Location of mine
VIRGINIA			
Blue Ridge Talc Co., Inc., Henry	Soapstone	Rough, ground	Near Henry Station, Franklin County.
Bull Run Talc & Soapstone Co., Inc., Clifton Station.	Talc	Ground	3 miles north of Clifton, Fairfax County.
Virginia Alberene Corporation, 419 Fourth Avenue, New York, N. Y.	Soapstone	Dimension stone, furnace blocks, special products, ground.	Schuyler, Nelson County.
WASHINGTON			
H. P. Scheel, Jr., Sedro Woolley	Talc	Rough	Near Marblemount, Skagit County.
Skagit Talc, Inc., Sedro Woolley	do	do	Near Rockport, Skagit County.

California.—In 1934, 10 companies in California produced 15,880 short tons of talc and soapstone valued at $164,777. The total quantity sold or used by producers increased 3.7 percent over 1933, but the value decreased 16.3 percent. Crude material sold at an average value of $5.83 per ton compared with $7.34 in 1933; the average value of ground talc decreased from $13.50 per ton in 1933 to $11.42 in 1934.

Among new producers were Drake, Davis & Davis, Bigpine, who operated the High Chief mine near Bigpine, Inyo County, and Frank McDonald, Shingle, who shipped soapstone from a point 1¼ miles from Shingle. Glendinning & Co., Los Angeles, produced talc from the Mount Whitney mine near Darwin, Inyo County, which was shipped to eastern consumers.

California talc has a wide range of uses. The State mineralogist [4] recently reported:

> California talc has in part replaced imported talc in the toilet trade on the basis of quality. Nearly 80 percent of this product in California is high-grade talc, mainly from Inyo and San Bernardino Counties, and is utilized mostly in toilet powders, paints, paper, and rubber manufacture, and also in ceramics and for polishing rice. The soapstone grades are being used mainly for roofing granules and as a filler in roofing paper and part also in magnesite-cement mixture. Some of the Eldorado Co. mineral, a steatite variety, has been used in electrical insulators.

Georgia.—The Cohutta Talc Co., Dalton, and the Georgia Talc Co., Asheville, N. C., shipped talc from their properties near Chatsworth, Murray County. The total output increased both in quantity and in value compared with 1933. The products were talc crayons and ground talc; the latter was consumed by the rubber, roofing, bleachery, foundry, and other trades.

Maryland.—Total talc and soapstone produced and sold in Maryland in 1934 increased in both quantity and value compared with 1933. The Maryland Mineral Co., Conowingo, shipped crude and ground talc from the Dunn mine near Oakwood, which it leased in June 1934. The Harford Talc & Quartz Co., Towson, continued to produce high-grade refractory talc for use in the manufacture of lava tips for gas burners and other purposes, and Herbert I. Oursler shipped talc schist from his property near Henryton, Carroll County.

[4] Bradley, Walter W., The Nonmetallic Minerals of California: Pit and Quarry, vol. 27, July 1934, pp. 35-36.

Michigan.—The Michigan Talc Mining Co., Detroit, operated its property 4 miles from Ishpeming and, for the first time, shipped crude talc for grinding purposes. The property was shut down late in the year, but it was reported [5] that the company "is now bailing out the shaft, and when this work is completed a diamond drill will be placed in operation underground to gain additional information concerning the deposit."

New Jersey and Pennsylvania.—In New Jersey the Jersey Materials Co., Easton, Pa., shipped ground talc produced at the Lizzie Clay mine near Phillipsburg. In Pennsylvania, C. K. Williams & Co. produced crude soapstone from the Fox quarry near Easton, Northampton County.

New York.—In 1934 the domestic talc output in New York was produced by the Carbola Chemical Co., Inc., the International Pulp Co., and the W. H. Loomis Talc Corporation. The total quantity was 57,580 short tons of ground talc valued at $681,184—a decline of 30 percent in quantity and value from 1933. Shipments included granular talc from Lewis County and fibrous talc from St. Lawrence County. The average value of the product was $11.83; in 1933 it was $11.73. New York talc is used chiefly in the paper, paint, and ceramic industries.

North Carolina.—Due to an increased output of pyrophyllite in 1934 the total output of talc and pyrophyllite in North Carolina increased 6.6 percent in quantity and 10.7 percent in value compared with 1933. The Nantahala Co., Andrews, did not operate its mine during the year. The Carolina Talc Co., Murphy, purchased the property of the Notla Talc Co. on April 1, 1934 and produced and sold talc crayons and ground talc. The Caroline Pyrophyllite Co., Staley, N. C., has been chartered to mine and refine pyrophyllite. It is reported [6] to be planning to work a "mountain of the mineral" near Staley, Randolph County. North Carolina talc is consumed largely by the rubber, paint, and ceramic industries.

Vermont.—In 1934 the total quantity of talc produced and sold by producers in Vermont was 34,243 short tons (mostly ground material) valued at $313,346. The entire output of the three producers, decreased 5.5 percent in quantity and increased 4.6 percent in value compared with 1933. A small quantity of talc crayons was manufactured and sold by the Eastern Magnesia Talc Co. Vermont talc is sold largely to paper, rubber, roofing, textile, and paint manufacturers.

Virginia.—In 1934 the output of talc and ground soapstone in Virginia declined sharply compared with 1933. Shipments of architectural soapstone also decreased. During the latter part of 1933 the Virginia Mining & Management Corporation, Richmond, leased the Rapidan property of the Soapstone Corporation, comprising 240 acres near Somerset. The corporation is planning to develop these deposits and to erect a plant at Orange, Va., to process the material.[7] Preparations were being made to produce quarry blocks in 1935.

Washington.—Two producers of crude talc in Washington furnished the entire output of 900 tons, valued at $3,250, which was used chiefly in the manufacture of furnace blocks. Operations were con ducted by H. P. Scheel, Jr., at his property near Marblemount, and

[5] Stone, vol. 56, March 1935, p. 99.
[6] Rock Products, vol. 38, January 1935, p. 29.
[7] Pit and Quarry, vol. 27, July 1934, p. 21.

by the Skagit Talc, Inc., near Rockport. The latter company is reported [8] to have "ordered several thousand dollar's worth of new machinery in order to modernize its plant for an increased demand for its products such as talc furnace blocks." It has been reported [9] that a firm known as "Talco, Inc.," of Seattle, Wash., has been incorporated to produce talc and soapstone.

FOREIGN TRADE [10]

Imports.—In 1934 the United States imported 20,449 tons of talc valued at $426,369, a decrease of 7.7 percent in tonnage and an increase of 8.9 percent in value compared with 1933. The average value per ton was $20.85, the highest since 1929 and slightly less than twice the average value of domestic production—$10.44. For several years the average value of the imported talc has exceeded that of domestic shipments but not as much as in 1934. The decline in average value per ton of imports, which from 1929 to 1933 was more rapid than the decline in average value of domestic shipments, was stopped abruptly by this 18-percent increase.

Canada and Italy supplied 69.6 percent of the imports—Canada 40.1 percent and Italy 29.5 percent. Imports of Canadian origin in 1934 declined 8 percent in quantity (almost the same percentage as the decline in Canadian production), but the value of the imported material increased 4.9 percent. Almost 2 percent less Italian talc was imported than in 1933, but its value increased more than 18 percent. French imports, third in importance, comprised 18.9 percent of the total and declined 28.2 percent in quantity and 11.2 percent in value. Japan, next in order with 7.4 percent of the imports, increased its talc shipments to the United States 43.3 percent in quantity and 52.8 percent in value over 1933.

The average value per ton increased for all talcs imported except Chinese, South African, and Kwantung, although for the latter the decrease was so little (2 cents) that it is insignificant. The Chinese material continued to be the most valuable—$146.56 per ton ($184.73 in 1933); probably it is high-grade stone for carving. Second to this, and most valuable among the large producers, is Italian talc at $35.11 a ton, an increase of 20 percent over the value of $29.16 in 1933. The highest grade talc in the world is said to be mined in Italy. Its superior color, freedom from grit and impurities, and fineness of grain make it especially suited for cosmetics. South African talc imports averaged $24.38 a ton and Indian imports, $21.20. France, an important producer of French (tailor's) chalk and toilet and lava grades of talc, sent to the United States 3,874 tons of material worth $18.66 a ton. Japanese imports were valued at $14.27 and Norwegian at $10.72 a ton. Canadian talc at $10.31 a ton, Kwantung at $9.36, and Russian at $5.79 are the only talcs valued at less than the average for American material.

In 1930 imports for consumption were equivalent to 14.4 percent of sales (tonnage) of domestic talc; in 1931, 14.3 percent; in 1932, 16.3 percent; in 1933, 13.3 percent; and in 1934, 14.7 percent.

[8] Rock Products, vol. 37, February 1934, p. 65.
[9] Rock Products, vol. 38, April 1935, p. 73.
[10] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Talc imported for consumption in the United States, 1930–34

Year	Crude and unground steatite and French chalk		Manufactures (except toilet preparations) wholly or partly finished		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1930	722	$28,306	25,057	$501,516	25,779	$529,822
1931	146	7,755	23,335	425,927	23,481	433,682
1932	162	4,099	19,926	355,836	20,088	359,935
1933	248	2,628	21,899	388,888	22,147	391,516
1934	204	4,729	20,245	421,640	20,449	426,369

Talc, steatite or soapstone, and French chalk, crude, manufactured, or ground, imported into the United States, 1933–34, by countries

Country	1933		1934 [1]	
	Short tons	Value	Short tons	Value
Austria	1	$69	1	$69
Canada	8,922	80,590	8,198	84,499
China	134	24,754	197	28,872
Egypt	11	347	(2)	7
France	5,397	81,404	3,874	72,270
Germany	1	79	2	822
Hong Kong	(2)	28	(2)	46
India (British)	61	1,002	56	1,187
Italy	6,140	179,040	6,025	211,535
Japan	1,061	14,196	1,520	21,690
Kwantung	168	1,575	101	945
Norway	22	158	230	2,465
Spain			(2)	30
Union of South Africa	28	709	26	634
U. S. S. R. (Russia)			219	1,268
United Kingdom			(2)	30
	21,946	383,951	20,449	426,369

[1] Data on total imports during 1934 may not be strictly comparable with figures published in previous reports of this series due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in the system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.
[2] Less than 1 ton.

Exports.—Exports of talcum and other powders from the United States are given in the following table. The figures for different years, however, are described in various ways and may not be entirely comparable.

Exports of talcum and other powders from the United States, 1930–34

Year	Description	Short tons	Value
1930	Talcum powder, in bulk	478	$36,410
1930	Powders—talcum (in packages), face, and compact toilet powders	(1)	1,447,928
1931	Powders—talcum, face, and compact	(1)	1,244,525
1932	do	(1)	646,605
1933	do	(1)	618,026
1934	do	(1)	598,404

[1] Quantity not recorded.

WORLD PRODUCTION

The following table gives the world production of talc and soapstone, 1930 to 1934, insofar as figures are available:

World production of talc and soapstone, 1930–34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
Australia:					
New South Wales	280	230	293	368	(2)
South Australia	811	817	1,071	1,399	(2)
Tasmania	14	15	5	9	(2)
Austria (exports)	18,530	16,979	17,276	20,854	(2)
Canada [3]	10,742	10,710	10,980	13,772	12,663
China (Manchuria)	(2)	42,891	44,316	(2)	(2)
Egypt	-------	-------	232	2,531	(2)
Finland	2,800	3,000	1,625	1,288	(2)
France	85,900	83,900	(2)	(2)	(2)
Germany (Bavaria)	5,794	4,208	3,197	(2)	(2)
Great Britain	188	163	262	169	(2)
Greece	256	484	618	(2)	(2)
India (British)	6,967	5,217	6,617	17,322	(2)
Italy	38,131	38,620	32,404	34,427	(2)
Morocco, French (exports)	561	693	837	526	(2)
Norway	14,996	11,392	13,536	19,885	(2)
Rumania	3,353	3,068	1,798	1,112	(2)
Spain	5,438	6,585	6,574	10,064	(2)
Sweden	5,117	4,837	4,525	4,396	(2)
Union of South Africa (Transvaal)	380	337	251	271	218
United States	[4] 162,734	[4] 148,553	[4] 111,784	[5] 148,840	[5] 128,310
Uruguay (exports)	1,463	1,789	2,625	1,270	879

[1] In addition to the countries listed talc is produced in Argentina, Brazil, and the U. S. S. R. (Russia) but data of production are not available.
[2] Data not available.
[3] Excluding soapstone, which is reported only by value and was as follows: 1930, $50,168; 1931, $34,439; 1932, $46,751; 1933, $43,593; 1934, $44,297. Soapstone is sold in the form of both blocks and powder.
[4] Figures represent sales of talc only. Bureau of Mines not at liberty to publish figures for soapstone.
[5] Figures represent total mine production of talc and ground soapstone.

TECHNICAL DEVELOPMENTS

Mechanical preparation.—The mechanical preparation of talc has been reviewed briefly by Tyler.[11] He says:

> The hard or "fibrous" talc, grading into tremolite, produced in New York State, is ground mainly in tube mills; the tendency is for air separators to replace screens formerly used to eliminate coarse waste from the product. Elsewhere Hardinge mills have been used alternatively with emery mills and roller mills, followed by air separators. Where sale is found for relatively coarse, granular product (roofing trade) or where grit and other hard impurities are to be eliminated, suitable pulverizers with a throw-out device have an important application. Ordinary flour mills were employed originally for grinding talc but despite the softness of the material, were not economical; the buhr mills had little capacity, and silk bolting cloth wore out rapidly. Wet grinding has been proposed for pyrophyllite but apparently has not been commercially adopted for talcose minerals in the United States. In grinding talc mixed with harder minerals, each grinding machine and various adjustments of the same machine may have a characteristic selective action. At one plant, for example, the best product (as regards whiteness, slip, and fineness) is obtained from a modified vertical emery mill with hard steel disks, but the yield was small.

For grinding soapstone waste [12] a hammer mill is used for secondary crushing (from about 1 to ¼ inch) and a ball mill for fine grinding. Coarser products (main tonnage minus 40- plus 48-mesh) are sized on Hum-mer screens, but the tube-mill product is air-classified to 97 percent through 300 mesh.

[11] Tyler, P. M., Mechanical Preparation of Nonmetallic Minerals: Trans. Am. Inst. Min. and Met. Eng., vol. 112, 1934, pp. 785–823.
[12] Hughes, H. H., Soapstone: Inf. Cir. 6563, Bureau of Mines, 1932, pp. 13–15.

Beneficiation of nonmetallics is becoming so important that it is not surprising that the talc industry is becoming interested. The Canadian Department of Mines [13] reduced the lime content of a soft white talc containing small rounded aggregates of harder dolomite from 5.7 to less than 0.5 percent by flotation, using soda ash in the pebble mill and potassium xanthate and water glass for flotation in a Ruth machine.

Rebinder, Lipetz, Rimskaya, and Taubman [14] included talc in the minerals on which they made fundamental wetting and flotation tests.

Sagger bodies.—Active research on talc as an ingredient of ceramic bodies continued in 1934. Loomis [15] studied a series of sagger bodies and recommended mixtures having enough strength both in the dry and fired state to permit construction with thinner walls and with better heat-shock resistance than the normal sagger body. Such changes should increase life and lower costs. Bodies containing a commercial grade of talc with several percent of lime had a much lower thermal expansion, considerably better heat-shock resistance, and usually a higher fired strength than bodies containing a very pure grade of talc. Although bodies made from limy talc had a little more tendency to sag than those made from the pure mineral, the sagging was less than with bodies containing no talc. Bodies containing 20 percent of finely ground, calcined kyanite and 10 percent of talc had the highest fired strength and showed little or no tendency to sag at high temperatures.

The Bureau of Standards [16] has investigated the effect of MgO on the physical properties of a sagger body, using talc and Grecian magnesite as the source of the magnesia. They conclude:

The P. C. E. (softening point) of the commercial sagger body used in the test was 27–28 (approximately 1,610° C.). When 2.5 percent talc was added the P. C. E. was 23; and with 5 percent talc 18–19 (1,500° C.). Bodies containing corresponding amounts of magnesium but in the form of magnesite had a P. C. E. of 26 (1,595° C.) and 20–23 (1,550° C.), respectively. The total linear thermal expansion in percent at 1,000° C. for the magnesium-free body was 0.592; that with 2.5 percent talc 0.535; with 5 percent talc 0.462. Corresponding bodies containing the magnesite showed 0.525 and 0.470 respectively.

The modulus of elasticity at room temperature expressed in 1,000 lb. per in.^{2} for the magnesium-free body was 1,125; for the 2.5-percent talc-containing body 765; the 5-percent talc 555; for the bodies containing equivalent percentages of magnesium but in the form of magnesite, 615 and 525, respectively. The modulus of rupture in lb. per in.^{2} for these five bodies was 630, 615, 480, 475, and 515, respectively.

The total plastic deformations (in inches) at the end of 2½ hours, at a temperature of 1,200° C., and with a constant load of approximately 6 lb. per in.^{2} placed at the center of a 1 by 1 by 9 inch specimen over an 8-inch span, were as follows: Sagger body without addition of talc or magnesite, 0.071; the 2.5-percent talc body, 0.039; the 5-percent talc body, 0.062; the corresponding magnesite-containing bodies, 0.023 and 0.0235, respectively.

The absorption ranged between 14 and 15 percent, the lower value being obtained in the body containing 5 percent talc.

Gaging the service life of the sagger from the $\frac{\text{modulus of rupture}}{\text{modulus of elasticity}}$ values, together with the total linear expansion at 250° C., it was found that with respect to resistance to thermal shock any one of the bodies containing either added

[13] Carnochan, R. K., and Rogers, R. A., Experimental Tests on Madoc Talc for the Separation of Dolomite: Canada Dept. Mines, Mines Branch, Rept. no. 736, 1934, pp. 231–234.

[14] Rebinder, P., Lipetz, Marie, Rimskaya, Marie, and Taubman, A., Physical Chemistry of Wetting Phenomena and Flotation Processes. IX: Kolloid Ztschr. vol. 65, 1933, pp. 268–283; Chem. Abs., vol. 28, 1934, 1906.[9]

[15] Loomis, G. A., Study of Sagger Bodies: Bul. Am. Ceram. Soc., vol. 14, 1935, pp. 8–12.

[16] National Bureau of Standards, Talc in Sagger Bodies: Tech. News Bull. 204, April 1934, pp. 39–40.

talc or magnesite should have a much longer life in service than the body containing none. Actual plant records on the 2.5-percent talc body in comparison with the talc-free body indicated the latter to have approximately one half the life of the former.

The plastic deformation (bulging of sagger bottoms) of the sagger body is decreased when measured under the conditions stated by the addition of either talc or magnesite to the body.

The limited amount of data obtained on the sagger body tend to show that (1) either talc or magnesite may advantageously be used in sagger bodies; (2) magnesite is preferable to talc; (3) 2.5-percent talc is probably more desirable than 5 percent, but the same does not hold true for magnesite.

Makhl [17] found talc mixes for sagger bodies superior in every respect to those containing dunite. The best bodies were those containing 15 percent talc.

Whiteware bodies.—Pursuant to a recommendation of the Industrial Advisory Committee on Whiteware to the Bureau of Standards, meeting in Washington, October 16, 1933, that Bureau has undertaken a study of whiteware bodies containing talc.[18] From 2.5 to 43 percent of lime-free talc and lime-bearing amphibole (marketed as talc) were added to whiteware bodies of the wall-tile type. Each specimen was heated to 1,120°, 1,180°, 1,260°, and 1,325° C. (approximately cones 1, 6, 10, and 14). The results obtained show that:

(*a*) An appreciable variation of MgO content did not significantly alter the water absorptivity of the heated bodies, this property being influenced much more, relatively, by the CaO and by the alkalies in the feldspar; (*b*) the total linear shrinkage was decreased, for specimens heated to 1,260° C., from a maximum of 8 percent for a body containing no talc to a minimum of 0.7 percent for a body containing 43 percent talc. The shrinkage, also, was influenced significantly by the CaO in the amphibole and the alkalies in the feldspar; (*c*) moisture expansion was practically eliminated, but this must be accounted for in part by the low feldspar content; (*d*) the total linear thermal expansion to 700° C., considering specimens heated to 1,260° and 1,325° C. only, was decreased from a maximum of 0.93 percent for a body containing neither alkalies nor MgO to 0.35 percent for a body containing 15 percent amphibole. In general the thermal expansions increased over 30 percent, and, other factors being equal, expansions of bodies containing talc were higher than of the comparable bodies of the amphibole series.[19]

Complete results of this investigation will be published shortly by R. F. Geller and A. S. Creamer.

The State Ceramic Institute at Leningrad, U. S. S. R , also has carried out some research on use of pyrophyllite in whiteware bodies.[20]

Other ceramic research.—The properties of ceramic materials containing talc as their principal ingredient are such that they have led to the wide use of these mixtures for low-loss dielectrics, high electrical resistance at high temperatures, and high mechanical strength in such articles as line insulators and spark plugs.[21] The Russians have found [22] that a mixture of washed Ural steatite (79 percent), refractory clay (10 percent), fine-ground feldspar (10 percent), and high-grade dextrin (1 percent) gave a satisfactory spark-plug insulator.

[17] Makhl, R. T., Talc and Dunite Sagger Mixes: Keram. i Steklo, vol. 10, no. 10, 1934, pp. 29–32.

[18] American Ceramic Society, Minutes of Meetings of Industrial Advisory Committee on Whiteware to the Bureau of Standards: Bull., vol. 13, 1934, pp. 212–213.

[19] National Bureau of Standards, Talc in White Ware: Tech. News Bull. 211, November 1934, p. 108; Jour. Franklin Inst., vol. 218, 1934, pp. 750–751.

[20] Ominin, L. V., Pyrophyllite as a Ceramic Material: Ukrainsky Silikaty, no. 6–7, 1932, pp. 136–140; Ceram. Abs., vol. 13, 1934, p. 187.

[21] Albers-Schonberg, E., Insulating Material of the Steatite Group: Electrotech. Ztschr., vol. 54, 1933, p. 547; Ceram. Abs., vol. 13, 1934, p. 267.

Albers, E., Steatite, Frequenta, and Magnesolite, Ceramic Insulating Materials for High-Frequency and Electro-Heat Techniques: Eng. Progress, vol. 15, 1934, pp. 157–160.

[22] Tereshtchenko, O. V., Ivanov, E. V., Chokolov, D. S., and Nabokova, M. A., Manufacture of Spark-Plug Insulators from Steatite of the Urals: Ukrainsky Silikaty, no. 10, 1932, pp. 267–276; Ceram. Abs., vol. 13, 1934, p. 186.

Becker [23] has patented a ceramic body containing 20 to 90 percent steatite. He claims that it can be fired at a low temperature and that it is resistant to rapid temperature variations.

Krause and Jäkel [23] have investigated the properties imparted to ceramic ware by talc. Using 15 different bodies, they found that (1) with increased temperature of the bodies, the coefficients of thermal expansion diminished; (2) the thermal expansion of all bodies becomes about the same with increased firing temperature; and (3) the coefficient of thermal expansion reaches its minimum value when the bodies lie in the mullite-corundum region of the three component system, especially when their composition approaches that of the theoretical cordierite.

Refractories.—Research on the use of talc in saggers and in whiteware, although extremely active, has not eliminated entirely studies of talc-rock refractories. In 1931 the Russian All-Union Institute for Scientific Research on Building Materials of Mineral Origin published a series of papers on this general subject.[24] The report presents interesting data. The talc rocks studied are recommended as refractory linings for kilns when the slag is basic and when the temperature does not exceed 1,400°. Preliminary burning of brick increases hardness, resistance to abrasion, softening point, and slagging resistance. The best firing temperature was 1,200° to 1,400°; heating should be gradual.[24 25]

Palei [26] found that talc brick used in a cement kiln lasted 61 operating days, whereas bricks of other compositions lasted 20 days. Mamykin [27] and the Steatite Magnesia Co.[28] also have presented data to show the superiority of talc to other materials for mill linings.

Molding ground material.—The molding of ground talc and soapstone with a binder has received surprisingly little attention. Budnikov and his associates [29] found that a firebrick made of ground talc and refractory clay gave reasonably good results up to 1,400°. A brick made by pressing ground talc rock and magnesite could be used up to 1,500° to 1,550° as a substitute for magnesite bricks. Sergiev [30] pressed waste talc chlorite into blocks with various cements and subjected them to practical tests.

[23] Becker, Géza, Ceramic Articles That Can Be Fired at Low Temperature: Hungarian Patent 107, 181, Sept. 1, 1933; Ceram. Abs., vol. 13, 1934, p. 267.

Krause, Otto, and Jäkel, Ernst, Thermal Expansion of Ceramic Bodies of the Three Component System $MgO-Al_2O_3-SiO_2$ Containing Steatite: Sprechsaal, vol. 67, 1934, pp. 509–511, 525–528, 543–544; Ceram. Abs., vol. 14, 1935, p. 56.

Krause, Otto, and Jäkel, Ernst, Talc Bodies of the Ternary System $MgO-Al_2O_3-SiO_2$: Ber. Deut. keram. Gesell., vol. 15, 1934, pp. 485–500; Building Sci. Abs., vol. 7, November 1934, p. 347.

[24] Arshinov, V. V., Use of Natural Silicates of Magnesium and Magnesite for Refractories: Trans. All Union Inst. for Sci. Res. on Building Materials of Mineral Origin, no. 3, 1931, pp. 7–17; Andreev, N. V., and Dneprovsky, M. A., Physical and Mechanical Properties of Schabrovsky Talc Rock: Ibid., pp. 18–27; Chetverikov, S. D., Petrographic Changes of Schabrovsky Talc Rock During Burning: Ibid., pp. 28–31; Shafir, L. N., and Andreev, N. V., Refractory Properties of Schabrovsky Talc Rock: Ibid., pp. 32–46; Mamykin, P. S., Syrostansky Talc Rock as a Refractory: Ibid., pp. 47–61; Nefediev, O. V., and Karianopulo, K. A., Resistance of Talc Rock of the Schabrovsky Deposit to Several Industrial Slags: Ibid., pp. 62–76; Budnikov, P. P., Kukolev, J. V., and Mandelgrin, E. L., Using Talc Waste as a Refractory Material: Ibid., pp. 77–81; Bazilevich, A., and Blinov, G., Technology of Artificial Talc and Talc-Magnesite Bricks: Ibid., pp. 82–95.

[25] Grigorovich, V. H., Hardness of Talc on Firing: Mineral. Suir'e, vol. 9, 1934, no. 5, pp. 50–57; Ceram. Abs., vol. 14, 1935, p. 72.

Nefed'eva, O. V., Makushevich, P. T., and Dvoretzkii, A. I., Mined Soapstone Brick for Boiler Combustion Chambers: Izvestiya Teplotekh. Inst., no. 4, 1933, pp. 36–47; Ceram. Abs., vol. 13, 1934, p. 122.

[26] Palei, A. M., Talc Rock as Lining Material for Sintering Zone of Revolving Furnaces: Ogneuporui, vol. 1, no. 2–3, 1933, pp. 36–37; abstracted in Chem. Zentralb., 1934, p. 914; Ceram. Abs., vol. 14, 1935, p. 41.

[27] Mamykin, P. S., Syrostansky Talc Rock as a Refractory: Trans. All-Union Inst. for Sci. Research on Building Materials of Mineral Origin, no. 3, 1931, pp. 47–61.

[28] Steatite Magnesia Co., Wear of Raw Materials in Mill Linings: Sprechsaal, vol. 67, no. 9, 1934, pp. 119–121; Ceram. Abs., vol. 13, 1934, p. 189.

[29] See footnote 24.

[30] Sergiev, N. G., Utilization of Waste Talc Chlorite Stone: Mineral. Suir'e, vol. 8, no. 10, 1933, pp. 40–48; Chem. Abs., vol. 28, 1934, 1834[8].

American Lava Corporation of Chattanooga, Tenn., has announced the introduction of Alsimag, "a new ceramic composition of practically pure steatite."[31] The manufacturer reports that:

Alsimag is the name given to a group of steatitic compositions differentiated by certain physical characteristics and designated by laboratory formula numbers. Most of these formulas are made up using ground talc of the steatitic variety as from 50 to 98 percent of the body. Some of these develop the highest mechanical strengths of commercial ceramic bodies, at the same time maintaining the other characteristics desired in ceramics of density, low porosity, and high resistance to heat and mechanical shocks. One composition provides an unusually low coefficient of expansion. These steatite compositions are used in radio because of the low-loss factors and high dielectric strength; in many electric heating appliances as terminal blocks, pyrometer lead insulators, and supports for the heating elements. It is generally used in the severe service of oil-burner ignitor tubes. It has a place in the chemical industry because it is not corroded by most alkalies and acids. The hardness of the material is useful in the textile industry as thread guides.

In fabricating, the semiplastic mass may be formed by extrusion and pressing on high-speed presses to produce completely or partly finished articles which may be machined further before firing at cones 14 to 15 which produces a white vitreous body somewhat similar in appearance to porcelain although much harder and nearly twice as strong.

Paper fillers.—The paper industry has studied the adsorption of dyes by talc when it is used as a paper filler.[32] The Russians are studying the suitability of their talcs for use as fillers in paper.[33]

Research on physical and chemical properties.—During the year several fundamental studies on the structure,[34] chemical composition,[35] physical properties,[36] heat capacity,[37] petrographic changes on heating,[38] and whiteness[39] of the talc minerals were completed.

Formation of talc.—The problem of the geological formation of talc and soapstone has been considered by several investigators.[40]

HEALTH HAZARDS

Results of early research on the effects of talc-dust inhalation indicated that talc was not one of the more hazardous industrial dusts. This opinion received a rude jolt in 1934 as a result of a study in the

[31] Industrial and Engineering Chemistry, Alsimag, a New Industrial Material: News ed., vol. 13, 1935, p. 182.

[32] Friedman, Leo, and Kuykendal, D. V., Jr., The Effect of pH upon the Adsorption of Dyes by Cellulose and Fillers: Paper Trade Jour., vol. 99, no. 12, 1934, pp. 103–105; Chem. Abs., vol. 28, 7525 [8].

[33] Kulev, I. G., and Muretov, M. V., Ural Fillers for Paper Industry: Materialui Vsesoyuz. Nauch.—Issledovatel. Inst. Bumazh. Tzellyuloz. Prom. (Trans. All-Union Sci. Research Inst., Paper Cellulose Ind.) 1932, no. 4, pp. 200–209; Chem. Abs., vol. 28, 1934, 5664 [7].

[34] Palacios, J., and Barasoain, J. A., Crystal Structure of Pyrophyllite, $Al_2(OH)_2Si_4O_{10}$: Anales soc. españ. fís. quím., vol. 32, 1934, pp. 271–274; abstracted in Chem. Ztg., 1934, p. 1754; Chem. Abs., vol. 28, 1934, 4687 [1]; Ceram. Abs., vol. 14, 1935. Gruner, J. W., The Crystal Structure of Talc and Pyrophyllite: Ztschr. Krist., vol. 88, 1934, pp. 412–419; Chem. Abs., vol. 28, 1934, 6605 [2]; Ceramic Abs., vol. 14, 1935, p. 50. Aminoff, G., and Broome, B., Penetration of Talc by Fast Electrons: Arkiv Kemi, Mineral. Geol. vol. 11B, no. 25, 1933, 5 pp.; Chem. Abs., vol. 28, 1934, 2987 [5]. Trendelenburg, Ferdinand, and Wieland, Otto, Electron Diffraction Investigations of Aluminum Silicates and Other Substances of the Layer Lattice Type: Wiss. Veröffert-lich. Siemens-Konzern, vol. 13, 1934, pp. 31–41; Chem. Abs., vol. 28, 1934, 7152 [7].

[35] Onorato, E., The Chemical Constitution of Natural Silicates: Rend. seminario facoltà sci. univ. Cagliari, vol. 2, 1932, pp. 25–30; Chem. Ztg., 1933, vol. I, p. 3300; Chem. Abs., vol. 28, 1934. 6088 [5]. *See also* footnote 20.

[36] Andreev, N. V., and Dneprovsky, M. A., Physical and Mechanical Properties of Schabrovsky Talc Rock: Trans. All-Union Inst. for Sci. Research on Building Materials of Mineral Origin, no. 3, 1931, pp. 18–27.

[37] Bazilevich, A., Heat Capacity of Mineral Raw Materials: Mineral. Suir'e, vol. 9, no. 3, 1934, pp. 48–50; Chem. Abs., vol. 28, 1934, 4635 [8]; Ceram. Abs., vol. 14, 1935, p. 82.

[38] Chetverikov, S. D., Petrographic Changes of Schabrovsky Talc Rock Duriug Burning: Trans. All-Union Inst. for Sci. Research on Building Materials of Mineral Origin, no. 3, 1931, pp. 28–31.

[39] Medvedeva, V. I., Whiteness of Minerals: Mineral. Suir'e, vol. 9, no. 1, 1934, pp. 20–29; Chem. Abs., vol. 28, 1934, 3691 [6].

[40] Hess, H. H., The Problem of Serpentinization and the Origin of Certain Chrysotile Asbestos, Talc and Soapstone Deposits: Econ. Geol., vol. 28, 1933, pp. 634–657. Hess, H. H., Hydrothermal Metamorphism of an Ultra-Basic Intrusive at Schuyler, Virginia: Am. Jour. Sci., 5th ser., vol. 26, 1933, pp. 377–408. Read, H. H., Zone Associations of Antigorite, Talc, Actinolite, Chlorite, and Biotite in Unst, Shetland Islands: Mineralog. Mag., vol. 23, 1934, pp. 519–540; Chem. Abs., vol. 28, 1934, 6094 [3]. Satô, S., Alteration of Talc and Antigorite to Leuchtenbergite in the Metamorphosed Dolomite of the Matenrei System, North Korea: Jour. Shanghai Sci. Inst., vol. 1, 1933, pp. 17–24; Chem. Abs., vol. 28, 1934, 6659 [4].

Chatsworth region by the United States Public Health Service and the Georgia State Department of Health.[41]

Physical and roentgenologic examinations were made of 66 men and women who were working in or had been exposed to talc dust. Of the 33 exposed to 300,000,000 particles or more per cubic foot 8 had pneumoconiosis I; 5, pneumoconiosis II; and 3, pneumoconiosis III. Of the 13 miners examined 6 showed pneumoconiosis I; no advanced stages were found in this group. No pneumoconiosis was found among those exposed to low concentrations of dust.

All dust concentrations in the mines and mills of the district were high. The average plant dustiness, exclusive of packing operations (1,672,000,000 particles per cubic foot), was 162,000,000 particles per cubic foot. In the mine a weighted average for the day was 135,000,000 particles per cubic foot.

The dust contained approximately 70 percent of talc as fibrous splinters, fibrous aggregates, and foliated masses; 20 to 30 percent of dolomite; no quartz; and, in two samples 10 percent of tremolite.

The Director of the Industrial Hygiene Division, Department of Health, Ottawa, Canada, stated during the year that the effect of talc dust was similar to that of quartz.[42]

USES OF TALC

The uses of talc have been discussed in some detail by Ladoo [43] and reviewed in the annual chapters of Mineral Resources of the United States for many years. In 1931 Bowles and Stoddard [44] summarized the subject and gave a table, prepared from a statistical canvass, showing the uses for which talc was sold in that year. The greatest change since that time is the increased importance of ceramic markets.

The uses of talc are determined largely by its physical rather than its chemical properties. In a recent article MacConkey [45] lists the properties desired in talc for various purposes.

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[41] Dreessen, W. C., and Dalla Valle, J. M., The Effects of Exposure to Dust in Two Georgia Talc Mills and Mines: U. S. Public Health Repts., vol. 50, no. 5, Feb. 1, 1935, pp. 131–143.

[42] Cunningham, J. G., Chemical Health Hazards in Industry: Chem. and Ind., vol. 53, 1934, pp. 707–710.

[43] Ladoo, R. B., Talc and Soapstone: Their Mining, Milling, Products, and Uses: Bull. 213, Bureau of Mines, 1923, pp. 65–82. Ladoo, R. B., Nonmetallic Minerals: Occurrence—Preparation—Utilization: McGraw-Hill Book Co., New York, 1925, pp. 557, 626–627.

[44] Bowles, Oliver, and Stoddard, B. H., Talc and Soapstone: Mineral Resources of the United States, 1931, Bureau of Mines, pt. II, pp. 100–101.

[45] MacConkey, C. A., Grading and Uses of Talc: Nat. Research Council (Canada), 1934, 46 pp.; Canadian Chem. and Met., vol. 19, 1935, p. 85.

FLUORSPAR AND CRYOLITE

By H. W. Davis

SUMMARY OUTLINE

FLUORSPAR

Summary.—Expanded activity at steel mills, the chief consumer of fluorspar, coupled with an increase in the average quantity of fluorspar used per ton of steel made, resulted in a consumption of about 20,600 tons more fluorspar by the steel industry in 1934 than in 1933. However, this increased consumption was not accompanied by a corresponding improvement in sales of fluorspar to steel mills, which were only about 9,600 tons more than in 1933 due to withdrawals from consumers' stocks which dropped from 56,900 tons in 1933 to 46,300 tons in 1934. Manufacturers of hydrofluoric acid, second in importance as a consumer of fluorspar, purchased about 5,700 tons more fluorspar in 1934 than in 1933. Makers of glass, the third largest user of fluorspar, purchased about 500 tons more fluorspar than in 1933, whereas manufacturers of enamel, the fourth largest consumer of fluorspar, purchased about 900 tons less.

The total sales of fluorspar to consumers in the United States were 101,662 short tons in 1934, of which 85,264 tons were from domestic mines and 16,398 tons were imported, compared with a total of 85,265 tons in 1933, of which 72,859 tons were from domestic mines and 12,406 tons were imported. The demand for domestic fluorspar in both years required only a small part of the potential productive capacity of mines and mills, the Illinois-Kentucky district alone having a rated annual capacity of 230,000 tons.[1]

Expansion of the operating rate at steel plants from about 33 percent of capacity in January 1934 to 56 percent in May 1934 was accompanied by an increase in the price of domestic fluxing-gravel fluorspar, which opened in January at $15 a short ton f. o. b. Illinois-Kentucky mines and by April had advanced to $17. However, the

[1] Fluorspar (pamphlet report privately printed by Illinois-Kentucky fluorspar producers), Nov. 5, 1934, p. 23.

sudden drop to 27 percent of capacity at steel mills in July 1934 weakened the price of Illinois-Kentucky fluorspar, and it was reduced to $15 a ton. Imported fluxing-gravel fluorspar at tidewater (duty paid) was quoted during January and February 1934 at $18.50 a short ton, but during the latter part of March it was advanced to $19, the quoted price for the remainder of 1934.

Salient statistics of the fluorspar industry in the United States, 1933–34

	1933		1934	
	Short tons	Value	Short tons	Value
Domestic shipments:				
Gravel	61,216	$782,976	74,249	$1,121,974
Lump	2,127	34,401	3,101	60,135
Ground	9,587	221,801	8,436	209,296
	72,930	1,039,178	85,786	1,391,405
Stocks at mines or shipping points:				
Ready-to-ship	44,777	(1)	50,586	(1)
Crude	42,008	(1)	33,326	(1)
	86,785	(1)	83,912	(1)
Imports for consumption:				
Containing more than 97 percent CaF_2	5,203	74,346	10,632	145,454
Containing not more than 97 percent CaF_2	5,195	30,955	6,073	37,832
	10,398	105,301	16,705	183,286
Exports	71	967	522	8,602
Consumption (by industries):				
Metallurgical	66,500	(1)	88,100	(1)
Ceramic	10,300	(1)	11,500	(1)
Chemical	7,800	(1)	11,000	(1)
	84,600	(1)	110,600	(1)
Stocks at consumers' plants Dec. 31:				
Metallurgical	57,800	(1)	47,400	(1)
Ceramic	2,700	(1)	2,500	(1)
Chemical	8,000	(1)	7,700	(1)
	68,500	(1)	57,600	(1)

1 Figures not available.

The further increase in consumption of acid-grade fluorspar as a refrigerating medium, the almost trebling of shipments of ground fluorspar from New Mexico, the phenomenal gain in shipments of fluxing-grade fluorspar from Colorado (some of which moved to steel plants in the eastern Pennsylvania and Buffalo (N. Y.) districts), the more than doubling of shipments of fluorspar from Kentucky for barge delivery at upper Ohio River landings, the reopening of fluorspar mines in New Hampshire, and the advance from 6.1 pounds in 1933 to 6.9 pounds in 1934 in the average quantity of fluorspar used per ton of steel made were noteworthy in 1934.

Trends in production, imports, consumption, and average value of fluorspar over a series of years are shown in figure 117.

Recent trends in employment and output per man-hour at fluorspar mines.—Although fluorspar mining in the United States is one of the smaller nonmetallic industries it represents a capital investment in the neighborhood of $10,000,000. In 1929 the industry paid out about $1,500,000 in wages and salaries and about $1,000,000 for supplies, materials, fuel, and machinery, notwithstanding the fact that the mines supplied only 73 percent of the domestic demand during that year. A comparison of the relative size on a national scale alone, however, does not illustrate adequately the great importance of fluorspar mining in the economic life of the sections of the States where the mines are located, particularly in the Illinois-Kentucky producing district where there is no other industry except agriculture. Because of its rugged character some of the land is not tillable, and much is rather poor for farming. Steady operation of the mines, therefore, is essential to the livelihood of the labor dependent on them and to the welfare of the communities which are the center of the fluorspar-producing industry.

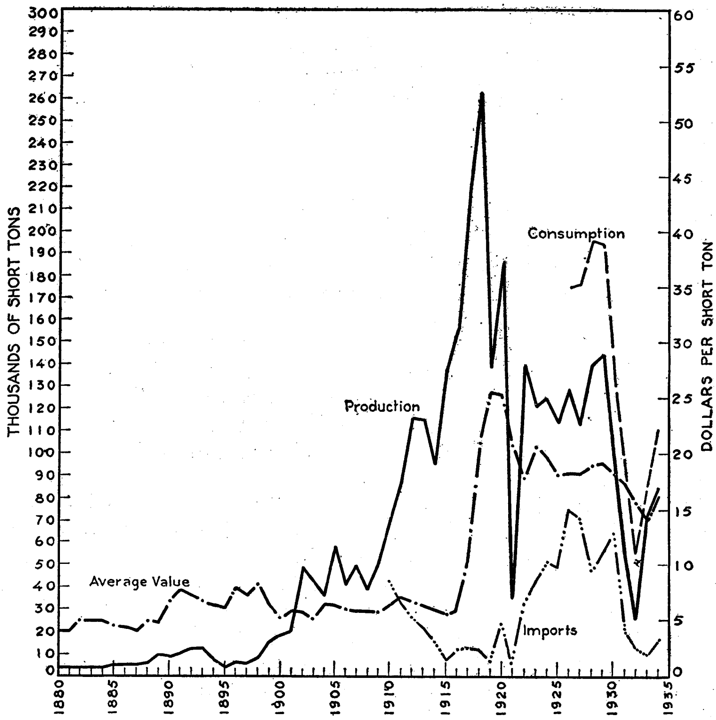

FIGURE 117.—Trends in production and average value per ton of fluorspar in the United States, 1880–1934; in imports, 1910–34; and in consumption, 1926–34.

Over roughly the first 3 decades of the twentieth century the number of men engaged in fluorspar mining quadrupled, and the value of the industry's output multiplied about elevenfold. The expansion of the industry from 1902 to 1929 is indicated in the following table, assembled from records of the Bureau of the Census.

The figures on employment exclude officials, clerks, and other subordinate salaried employees as well as all men engaged in contract hauling of fluorspar. It is doubtful, moreover, to what extent the decennial canvasses included small mines and prospects that produced ore in small quantities and gave irregular employment to an undetermined number of men.

Growth of the fluorspar industry in the United States from 1902 to 1929 [1]

	Number of mines and quarries	Wage earners (average for year)	Principal expenses					Machinery and other equipment purchased during year	Value of products produced
			Wages	Contract work	Supplies and materials	Fuel	Purchased electric energy		
1929:									
Colorado	3	25	$43,064	--------	$3,913	$3,868	--------	$1,650	$51,239
Illinois	7	474	563,024	$9,925	244,682	70,758	$9,317	60,811	1,434,122
Kentucky	23	529	487,580	--------	374,649	77,032	13,521	75,613	1,328,733
Nevada New Mexico	2 1	} 25	18,654	6,615	3,256	1,790	768	1,590	44,250
Total	36	1,053	1,112,322	16,540	626,500	153,448	23,606	139,664	2,858,344
1919: Total	72	1,124	1,195,777	145,916	634,498	163,239		(2)	3,334,880
1909: Total	15	290	168,445	949	34,695	24,414		(2)	288,509
1902: Total	22	269	110,002	300	31,374	(2)		(2)	275,682

[1] Assembled from data published in Mines and Quarries, Bureau of the Census.
[2] Figures not available.

The Bureau of Mines has been able to supplement decennial figures of the Bureau of the Census as well as to provide a new series of information on employment and output per man. For many years virtually all the important fluorspar-mining companies, whose interest in safety work is well known, have reported annual data on employment to the Bureau of Mines for use in the compilation of accident statistics. The figures on hours of labor and other employment information for the 8-year period 1926–33 have been correlated with statistics on production, also reported by producers, and the detailed results are summarized in the table on page 1090, which forms the principal statistical background of this discussion.

On account of the different types of fluorspar deposits, irregular character of the ore bodies, shifts in sources of production, changes in rates of operation, extent of exploration, development and maintenance, and variation in size of mines, methods of working, and efficiency of operation it is obvious that the amount of human energy expended to produce a unit of fluorspar will vary from year to year not only at mines of different types but at mines of the same type. This wide variation in the productivity of labor is illustrated in the following summary table, which shows that the composite average output of merchantable fluorspar at mines covered by the study ranged from 97 to 113 pounds per man-hour during the period 1926–29 and from 75 to 122 pounds per man-hour during 1930–33.

Summary of employment at fluorspar mines and mills in the United States, merchantable fluorspar produced, and average output per man, 1926–33 [1]

Year	Employment at mines and mills			Production		
	Average number of men employed	Time employed		Merchantable fluorspar (short tons)	Average pounds of merchantable fluorspar per man	
		Average number of days	Average number of man-hours per day		Per day	Per hour
1926	1,168	269	8.23	125,600	799	97
1927	1,113	238	8.21	105,100	794	97
1928	1,008	279	8.22	112,500	800	97
1929	1,181	254	8.14	138,200	921	113
1930	1,126	210	8.19	118,700	1,003	122
1931	742	135	8.34	49,300	981	118
1932	314	147	8.11	14,100	611	75
1933	577	195	8.02	45,200	805	100
Average, 1926–33	904	229	8.19	88,600	856	104

[1] Covers operations at mines and mills furnishing from 66 percent in 1932 to 92 percent in 1926 and averaging 89 percent of the total fluorspar produced during the 8-year period covered by study.

The years 1926–29 represent a period of greatly increased demand for fluorspar, the average annual requirements of consumers in the United States being about 193,400 short tons. Although domestic mines were called upon to supply only 68 percent of these requirements production schedules were increased substantially, a vigorous exploration and development program was undertaken, and noteworthy improvements and refinements were made in mill flow sheets. The Bureau of Mines figures for 1929 vary slightly from the Census figures for the same year; this is due chiefly to the difference in statistical procedures employed. For example, the Bureau of Mines shows the average number of men employed at mines and mills during the actual period of operation, whereas the Bureau of the Census averages monthly totals of employment to arrive at an average for the year.

During the 4 years prior to 1930 the labor force was employed steadily, as most of the larger and many of the smaller mines were operated regularly, some on two shifts. However, as a relatively large proportion of the workers was engaged in exploration and development, the composite average output of about 97 pounds of fluorspar per man-hour during 1926, 1927, and 1928 was considerably less than in later years (except 1932) when most of the labor was expended in mining. Obviously, a mine that uses a considerable part of its labor force in exploration and development will show proportionately a smaller immediate return for the amount of human energy expended than a mine that devotes most of its efforts to mining. The benefits from the extensive exploration and development program were partly reflected in the results for 1929, when the composite average output increased to 113 pounds per man-hour.

The period from 1930 through 1933 is in vivid contrast to the statistical record from 1926 to 1929 and represents years of sharply reduced demand for fluorspar, suspension and curtailment of production schedules, and comparatively little exploration and development; the labor force was reduced and work was distributed among as large a number of employees as practical. Notwithstanding the depressed conditions prevailing during this period, the average output per man-hour in each year except 1932 was considerably higher than the average for the period 1926–29. This improvement in productivity of labor was due, partly at least, to the fact that relatively less human energy was expended in development and more in mining ore; also, more selective mining followed the development of many large new ore bodies, which were discovered during the extensive exploratory program largely completed in 1929. Moreover, improved mill flow sheets resulted in better separation of fluorspar and gangue and recovery of a somewhat larger percentage of the fluorspar.

The different types of deposits, size of mines, and method of working account for the rather wide variation in the productivity of labor in Illinois compared with Kentucky, as shown in the statistical record. The deposits of fluorspar in Illinois comprise chiefly vein deposits, which occur in fault fissures and usually are mined by vertical shafts and drifts, and bedded deposits, which are formed by replacement of limestone and are mined by shafts, adits, room and pillar stopes, and opencuts; most of the output from these deposits was obtained from a few large, well-mechanized mines which follow orderly systems of mining. On the other hand, the Kentucky deposits comprise vein deposits similar to but in general not as extensively developed as those in Illinois and superficial deposits formed by weathering of fissure veins and usually worked by primitive methods; the Kentucky output was obtained from a comparatively large number of mines and prospects, of which only a few have much modern mechanical equipment or employ systematic plans of mining. Mines in Illinois therefore show a consistently better performance in producing fluorspar than those in Kentucky and from 1926 to 1933 the composite average output ranged from 80 to 151 pounds per man-hour in Illinois compared with 70 to 106 pounds per man-hour in Kentucky.

The extent of exploration, development, and maintenance and their effect on the productivity of labor also are reflected in the statistical record. In Illinois, for example, the amount of human effort spent in exploration and development in 1926–29 reduced the average hourly output per man from 149 pounds in 1926 to 112 pounds in 1928; the benefits from such work were reaped in an increased output per worker in later years (except 1932) and reached a peak of 151 pounds per man-hour in 1931. It should also be noted, however, that when the market for a sizable part of the potential mine output disappears, as in 1932, a sharply reduced output per worker follows. This is due to the fact that about the same amount of labor is required regularly for constant dewatering and other maintenance work, so that proportionately more man-hours of labor per unit of output are expended in years of very poor demand than in years of reasonably brisk demand.

Notwithstanding much exploration and development work in Kentucky during 1926–30 the average output per man-hour increased progressively from 76 pounds in 1926 to 106 pounds in 1930. This improved performance was due chiefly to the fact that the greater part of the output was obtained from mines of the fissure-vein type, the most productive of which have much mechanical equipment and follow more or less orderly systems of mining. Sharply reduced demand and prices in 1931, followed by more drastic declines in 1932, were accompanied by suspension or curtailment of production schedules and staggering of available work at most mines of this type; the chief source of supply shifted to shallow deposits worked by primitive methods with a meager return to the workers. The influence of these conditions was reflected in a low return for the labor expended and a reduced output per worker, which dropped from 106 pounds per man-hour in 1930 to 71 and 70 pounds, respectively, per man-hour in 1932 and 1933.

The following table gives details on employment at fluorspar mines and mills, the quantity of ore mined and milled, and the average output of fluorspar per man-hour for 1926–33, by years, States, and groups of States. Unfortunately, information on employment at all operations was not reported; however, as the compilation includes mines producing about 89 percent of the total output for the 8-year period 1926–33, the figures are regarded as adequately representative. As already noted, the reports received from the producing companies do not include salaried employees, such as office workers. Moreover, an undetermined number of employees, such as those engaged in hauling fluorspar, are not included, as such work usually is done on a contract basis and no record of the number of men or length of time employed is kept by the mining companies.

Employment at fluorspar mines and mills in the United States, quantity of ore mined and milled, and average output of fluorspar per man, 1926–33, by States [1] [2]

State	Employment at mines and mills [1]					Production [2]										
		Time employed				Crude ore mined (partly estimated)			Crude ore [3] washed or milled and merchantable fluorspar recovered							
				Man-hours			Covered by study				Covered by study					
											Crude ore [3] washed or milled (partly estimated)		Merchantable fluorspar recovered			
															Average pounds per man	
	Average number of men employed	Average number of days	Total man-shifts	Average per day	Total	Total (short tons)	Short tons	Percent of total	Total crude ore [3] washed or milled (partly estimated) (short tons)	Total merchantable fluorspar recovered (short tons)	Short tons	Percent of total	Short tons	Percent of total	Per day	Per hour
1926																
Illinois	321	285	91,589	8.00	732,712	84,600	83,700	98.94	92,500	55,400	90,700	98.05	54,700	98.74	1,194	149
Kentucky	691	272	187,835	8.39	1,575,710	134,700	116,500	86.49	135,400	71,900	119,600	88.33	59,700	83.03	636	76
Colorado, New Mexico	156	224	34,922	8.00	279,376	27,500	26,200	95.27	27,000	12,200	25,700	95.19	11,200	91.80	641	80
Total	1,168	269	314,346	8.23	2,587,798	246,800	226,400	91.73	254,900	139,500	236,000	92.59	125,600	90.04	799	97
1927																
Illinois	355	250	88,768	8.01	710,944	87,900	86,300	98.18	87,300	48,800	85,400	97.82	47,000	96.31	1,059	132
Kentucky	671	235	157,485	8.34	1,313,714	113,400	98,600	86.95	111,500	61,000	96,700	86.73	50,400	82.62	640	77
Colorado, New Mexico	87	214	18,642	8.00	149,136	16,600	14,800	89.16	17,000	9,200	15,100	88.82	7,700	83.70	826	103
Total	1,113	238	264,895	8.21	2,173,794	217,900	199,700	91.65	215,800	119,000	197,200	91.38	105,100	88.32	794	97
1928																
Illinois	423	295	124,640	8.04	1,002,332	117,200	108,400	92.49	115,500	60,300	109,900	95.15	56,200	93.20	902	112
Kentucky	510	277	141,481	8.27	1,170,194	135,900	111,200	81.82	124,100	66,200	99,500	80.18	53,000	80.06	749	91
Colorado, Nevada, New Mexico	75	202	15,173	9.12	138,384	11,000	8,900	80.91	10,400	5,000	8,300	79.81	3,300	66.00	435	48
Total	1,008	279	281,294	8.22	2,310,910	264,100	228,500	86.52	250,000	131,500	217,700	87.08	112,500	85.55	800	97

1929																
Illinois	551	270	148,766	8.00	1,190,128	120,500	120,100	99.67	125,400	72,100	125,100	99.76	71,800	99.58	965	121
Kentucky	551	258	142,119	8.29	1,177,953	125,200	98,700	78.83	140,000	76,500	114,000	81.43	60,300	78.82	849	102
Colorado, Nevada, New Mexico	79	117	9,267	8.00	74,136	16,000	12,600	78.75	16,000	8,600	12,600	78.75	6,100	70.93	1,316	165
Total	1,181	254	300,152	8.14	2,442,217	261,700	231,400	88.42	281,400	157,200	251,700	89.45	138,200	87.91	921	113
1930																
Illinois	561	210	117,805	8.08	951,489	111,300	111,200	99.91	112,600	64,200	112,500	99.91	64,100	99.84	1,088	135
Kentucky	495	197	97,742	8.38	819,037	94,100	74,500	79.17	95,400	55,200	75,800	79.45	43,400	78.62	888	106
Colorado, Nevada, New Mexico	70	302	21,106	7.98	168,398	21,700	19,700	90.78	21,700	12,600	19,700	90.78	11,200	88.89	1,061	133
Total	1,126	210	236,653	8.19	1,938,924	227,100	205,400	90.44	229,700	132,000	208,000	90.55	118,700	89.92	1,003	122
1931																
Illinois	409	130	53,053	8.05	426,872	56,900	56,800	99.82	61,700	32,400	61,600	99.84	32,300	99.69	1,218	151
Kentucky	250	157	39,275	8.80	345,431	34,700	24,700	71.18	35,900	22,800	26,500	73.82	15,000	65.79	764	87
Colorado, Nevada, New Mexico	83	98	8,170	8.00	65,360	2,500	2,400	96.00	2,500	2,100	2,400	96.00	2,000	95.24	490	61
Total	742	135	100,498	8.34	837,663	94,100	83,900	89.16	100,100	57,300	90,500	90.41	49,300	86.04	981	118
1932																
Illinois	180	115	20,711	8.00	165,687	7,500	7,400	98.67	24,200	6,600	24,200	100.00	6,600	100.00	637	80
Kentucky	123	197	24,236	8.22	199,146	18,000	9,700	53.89	18,000	13,500	9,700	53.89	7,100	52.59	586	71
Colorado, New Mexico	11	110	1,213	8.00	9,704	1,100	500	45.45	1,100	900	500	45.45	400	44.44	660	82
Total	314	147	46,160	8.11	374,537	26,600	17,600	66.17	43,300	21,000	34,400	79.45	14,100	67.14	611	75
1933																
Illinois	307	204	62,493	8.00	499,968	66,000	63,500	96.21	92,400	32,000	90,800	98.27	31,100	97.19	995	124
Kentucky	246	194	47,842	8.04	384,474	39,100	25,400	64.96	39,500	24,300	25,600	64.81	13,500	55.56	564	70
Colorado, Nevada, New Mexico	24	80	1,931	8.00	15,448	3,100	600	19.35	3,100	2,300	600	19.35	600	26.09	621	78
Total	577	195	112,266	8.02	899,890	108,200	89,500	82.72	135,000	58,600	117,000	86.67	45,200	77.13	805	100

[1] Includes men and employment at mines and mills producing from 66 percent in 1932 to 92 percent in 1926 and averaging 89 percent of the total fluorspar produced during the 8-year period covered by study; excludes officials, clerks, and other subordinate salaried employees as well as all men engaged in contract hauling of fluorspar.

[2] Excludes 13,739 short tons of concentrates (3,637 tons in 1929, 6,996 tons in 1930, and 3,106 tons in 1931) recovered from 37,439 tons of fluorspar-bearing material (chiefly tailings) at the flotation plant at Rosiclare, Ill.

[3] Includes a comparatively small quantity of run-of-mine fluorspar not washed or milled.

4744—35——70

Production and shipments.—In 1934 fluorspar was produced at 93 mines or prospects (and at an undetermined number of storage yards, mill ponds, and waste dumps) which yielded the equivalent of about 87,000 short tons of merchantable fluorspar. In 1933, 66 mines or prospects were worked and yielded about 59,000 tons of merchantable fluorspar.

Shipments of fluorspar from domestic mines aggregated 85,786 short tons valued at $1,391,405 in 1934, an increase of 18 percent in quantity and 34 percent in total value compared with 1933, but only 69 percent of the average annual tonnage shipped in the 5-year period 1926–30. The general average value for all grades was $16.22 a ton in 1934, or $1.97 more than the 1933 average. The value recorded for domestic fluorspar is the price paid f. o. b. mine shipping point by the consumer and excludes the cost of containers. The general average value per ton of the fluorspar shipped to steel plants from the Illinois-Kentucky district was $15.28 in 1934 compared with $12.83 in 1933.

The following table presents such details of shipments of fluorspar from 1931 to 1934 by States as may be published without revealing, except by permission, data supplied by individual producers.

Fluorspar shipped from mines in the United States, 1931–34, by States

State	Grave			Lump			Ground			Total		
	Short tons	Value		Short tons	Value		Short tons	Value		Short tons	Value	
		Total	Average		Total	Average		Total	Average		Total	Average
1931												
Colorado	500	$5,533	$11.07	29	$388	$13.38				529	$5,921	$11.19
Illinois	23,632	341,534	14.45	1,098			3,342			28,072	468,386	16.69
Kentucky	19,006	303,648	15.98	497	32,715	19.98	3,959	$230,156	$31.29	23,462	437,642	18.65
New Mexico	972	17,301	13.06				54			1,026	19,326	13.60
Nevada	353			42						395		
	44,463	668,016	15.02	1,666	33,103	19.87	7,355	230,156	31.29	53,484	931,275	17.41
1932												
Colorado	333	3,330	10.00							333	3,330	10.00
Illinois	7,460	99,554	13.35	542			1,613			9,615	156,279	16.25
Kentucky	10,920	124,417	11.39	668	22,155	17.16	3,137	137,993	28.63	14,725	225,052	15.28
New Mexico	427	5,050	11.83	32			70			529	7,838	13.56
Nevada				49						49		
	19,140	232,351	12.14	1,291	22,155	17.16	4,820	137,993	28.63	25,251	392,499	15.54
1933												
Colorado	742	6,778	9.13							742	6,778	9.13
Illinois	29,694	395,492	13.32	357			6,024			36,075	543,060	15.05
Kentucky	30,035	371,669	12.37	1,716	34,401	16.17	2,863	221,801	23.14	34,614	469,451	13.56
New Mexico	294	9,037	12.13				700			994	19,889	13.27
Nevada	451			54						505		
	61,216	782,976	12.79	2,127	34,401	16.17	9,587	221,801	23.14	72,930	1,039,178	14.25
1934												
Colorado	6,537	83,132	12.72							6,537	83,132	12.72
Illinois	28,922	457,050	15.80	572	60,135	19.39	3,740			33,234	567,396	17.07
Kentucky	37,942	570,538	15.04	2,529			2,692	209,296	24.81	43,163	690,990	16.01
Nevada	627						4			631		
New Mexico	40	11,254	13.27				2,000			2,040	49,887	17.49
California	181									181		
	74,249	1,121,974	15.11	3,101	60,135	19.39	8,436	209,296	24.81	85,786	1,391,405	16.22

Shipments, by uses.—The two following tables show the relative dependence of the fluorspar industry upon the different industries in which fluorspar is used. The predominance of the steel industry as a purchaser of fluorspar is evident.

Fluorspar shipped from mines in the United States, 1933–34, by uses

Use	1933				1934			
	Percent	Short tons	Value		Percent	Short tons	Value	
			Total	Average			Total	Average
Steel	82.66	60,279	$769,889	$12.77	82.38	70,672	$1,061,864	$15.03
Foundry	1.42	1,039	13,791	13.27	1.74	1,489	23,807	15.99
Glass	9.29	6,778	147,985	21.83	8.56	7,343	167,182	22.77
Enamel and vitrolite	4.25	3,100	76,932	24.82	3.02	2,590	67,849	26.20
Hydrofluoric acid and derivatives	1.30	950	18,604	19.58	1.94	1,666	35,708	21.43
Miscellaneous	.98	713	11,010	15.44	1.75	1,504	26,393	17.55
	99.90	72,859	1,038,211	14.25	99.39	85,264	1,382,803	16.22
Exported	.10	71	967	13.62	.61	522	8,602	16.48
	100.00	72,930	1,039,178	14.25	100.00	85,786	1,391,405	16.22

Fluorspar shipped from mines in the United States, 1930–34, by uses

Year	Steel		Foundry		Glass		Enamel and vitrolite	
	Short tons	Average value	Short tons	Average value	Short tons	Average value	Short tons	Average value
1930	76,837	$16.13	2,209	$18.69	3,158	$32.92	2,188	$33.61
1931	39,832	14.16	1,123	16.10	5,279	30.74	1,996	32.79
1932	18,881	12.13	524	14.57	3,596	28.30	1,261	28.80
1933	60,279	12.77	1,039	13.27	6,778	21.83	3,100	24.82
1934	70,672	15.03	1,489	15.99	7,343	22.77	2,590	26.20

Year	Hydrofluoric acid and derivatives		Miscellaneous		Exported		Total	
	Short tons	Average value	Short tons	Average value	Short tons	Average value	Short tons	Average value
1930	9,834	$26.45	1,342	$16.32	281	$21.92	95,849	$18.22
1931	4,386	24.65	557	14.13	311	18.00	53,484	17.41
1932	738	19.79	226	11.91	25	22.12	25,251	15.54
1933	950	19.58	713	15.44	71	13.62	72,930	14.25
1934	1,666	21.43	1,504	17.55	522	16.48	85,786	16.22

Consumption—stocks at consumers' plants.—The following table gives data on consumption of fluorspar in 1933 and 1934 and on stocks at consumers' plants at the close of these years.

Fluorspar consumed and in stock in the United States, 1933–34, by industries, in short tons

[Partly estimated by Bureau of Mines]

Industry	1933		1934	
	Consumption	Stocks at consumers' plants Dec. 31	Consumption	Stocks at consumers' plants Dec. 31
Basic open-hearth steel	61,300	56,000	81,000	45,500
Electric furnace steel	3,400	900	4,300	800
Foundry	900	600	1,600	500
Ferro-alloys	300	200	500	200
Hydrofluoric acid and derivatives	7,800	8,000	11,000	7,700
Enamel and vitrolite	3,200	1,100	3,500	700
Glass	7,000	1,300	7,700	1,600
Miscellaneous	700	400	1,000	600
	84,600	68,500	110,600	57,600

The following table shows the relation of consumption of fluorspar to production of basic open-hearth steel from 1930 to 1934 and the stocks of fluorspar at such steel plants at the close of each of these years.

Consumption and stocks of fluorspar at basic open-hearth steel plants, 1930–34

	1930	1931	1932	1933	1934
Production of basic open-hearth steel long tons	34,268,316	22,130,398	11,742,682	20,057,146	23,256,417
Consumption of fluorspar in basic open-hearth steel production short tons	109,000	66,200	36,300	61,300	81,000
Consumption of fluorspar per ton of steel made pounds	6.3	6.0	6.2	6.1	6.9
Stocks of fluorspar on hand at steel plants at end of year short tons	89,000	67,600	55,000	56,000	45,500

The quantity of fluorspar used by individual plants per ton of basic open-hearth steel made ranges from 1 to 50 pounds. The average is generally 5 to 8 pounds—a very small proportion of the furnace charge. The average quantity of fluorspar used per ton of basic open-hearth steel made increased from 6.1 pounds in 1933 to 6.9 pounds in 1934, the highest average since 1928. The following table shows the variation in average consumption of fluorspar per ton of basic open-hearth steel over a 5-year period in certain plants that make about 88 percent of the total.

Average consumption of fluorspar per ton of steel, 1930–34, in pounds

1930	1931	1932	1933	1934	1930	1931	1932	1933	1934
16.931	16.111	14.176	18.944	14.443	6.276	6.219	6.646	6.754	6.584
6.559	5.781	4.572	3.864	4.766	10.651	7.784	6.056	8.148	9.820
4.768	4.613	5.122	4.687	5.141	5.311	2.437	2.636	4.097	4.511
6.544	2.431	6.136	5.731	9.958	9.720	5.774	6.356	5.386	5.900
2.545	4.867	6.281	6.871	6.195	6.118	5.822	6.118	6.590	6.429
5.661	5.856	5.171	5.858	5.768	6.606	3.791	6.260	6.099	6.780
5.555	4.978	6.842	4.289	5.046	7.087	7.049	6.322	7.449	8.331
7.705	6.590	5.302	5.659	7.488					

Quoted prices.—The following table shows representative quoted prices in 1934 on fluxing-gravel and foundry-lump fluorspar at Illinois-Kentucky mines and fluxing-gravel fluorspar at seaboard. These prices are for carload or barge lots. Prices quoted for smaller lots generally are somewhat higher than prices for large tonnages sold on contract.

Quoted prices per short ton of fluorspar in the United States in 1934

Month	Illinois-Kentucky (f.o.b. mines)			Imported (at seaboard, duty paid) [1]
	Fluxing gravel (not less than 85 percent CaF_2 and not over 5 percent SiO_2)		Foundry lump (not less than 85 percent CaF_2 and not over 5 percent SiO_2)	Fluxing gravel (not less than 85 percent CaF_2 and not over 5 percent SiO_2)
	Rail delivery	Barge delivery at Ohio River landings		
January	$15.00	$16.00	$15.00	$18.50
February	15.50	16.00	16.25	18.50
March	16.00	17.00	20.00	$18.50-19.00
April	17.00	17.00	----------	19.00
May	17.00	17.00	----------	19.00
June	17.00	17.00	16.00	19.00
July	15.00	16.00	16.00	19.00
August	16.00	16.00	14.50	19.00
September	16.00	16.00	----------	19.00
October	16.00	16.00	----------	19.00
November	16.00	16.00	----------	19.00
December	15.00	15.50	15.00	19.00

[1] Iron Age, vols. 133 and 134, 1934.

Stocks at mines or shipping points.—According to reports of producers the total quantity of fluorspar in stock at mines or shipping points at the close of 1934 was 83,912 short tons, a decrease of 3 percent from 1933. These stocks consisted of about 33,300 tons of crude fluorspar (calculated to be equivalent to 14,600 tons of ready-to-ship fluorspar) and 50,586 tons of ready-to-ship fluorspar.

Stocks of fluorspar at mines or shipping points in the United States, 1933–34, by States, in short tons

State	1933			1934		
	Crude [1]	Ready-to-ship	Total	Crude [1]	Ready-to-ship	Total
California	----------	----------	----------	50	----------	50
Colorado	255	20	275	235	78	313
Illinois	8,904	28,966	37,870	8,372	25,725	34,097
Kentucky	32,368	15,614	47,982	24,246	24,681	48,927
Nevada	433	125	558	375	50	425
New Mexico	----------	52	52	----------	52	52
Texas	48	----------	48	48	----------	48
	42,008	44,777	86,785	33,326	50,586	83,912

[1] The greater part of this crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

THE INDUSTRY IN 1934, BY STATES

CALIFORNIA

Shipments of fluorspar from California, amounting to 181 short tons, were reported from a deposit near Afton, San Bernardino County, during the fiscal year ended June 30, 1934. The fluorspar was hand-sorted and shipped to steel plants.

COLORADO

Greatly increased output at mines in Chaffee County and reopening of the Wagon Wheel Gap mine in Mineral County are reflected in the shipments of 6,537 short tons of fluorspar from Colorado in 1934, compared with 742 tons in 1933. Of the 1934 shipments, 6,479 tons went to steel plants, 46 tons to ferro-alloy plants, and 12 tons to cement plants. The shipments in 1934 consisted of 687 short tons from Boulder County, 2,573 tons from Chaffee County, 12 tons from Jackson County, and 3,265 tons from Mineral County. The production of 2,500 tons of fluorspar from a newly opened mine in the Chaffee County field and the movement of some fluorspar from the Chaffee County field to steel plants in the eastern Pennsylvania and Buffalo (N. Y.) districts in 1934 are noteworthy. Most of the fluorspar produced in the Chaffee County field was, except for crushing, shipped as it came from the mines. However, it is reported a washer was installed at one property during 1934. At another property flotation and grinding tests have been made on the ore with satisfactory results and a mill comprising flotation machines, a grinding unit, and other necessary equipment is contemplated during 1935.

ILLINOIS

Approximately 68,700 short tons of fluorspar-bearing material, equivalent to about 29,700 tons of merchantable fluorspar, were mined at 17 mines or prospects in Illinois in 1934 compared with 66,000 tons, equivalent to 30,000 tons of merchantable fluorspar, mined at 15 mines or prospects in 1933. Of the crude ore mined in 1934, 47,600 tons equivalent to 16,600 tons of merchantable fluorspar were from mines where the fluorspar occurs in veins chiefly in fault fissures and 21,100 tons equivalent to 13,100 tons of merchantable fluorspar from mines where the fluorspar occurs in flat-lying tabular masses, locally called blanket formations.

Fluorspar-bearing material milled in Illinois in 1934 totaled 68,800 tons, from which 29,500 tons of merchantable fluorspar were recovered—a ratio of 2.33 : 1.

Shipments from Illinois were 33,234 short tons in 1934 compared with 36,075 tons in 1933. Of the 1934 total, 15,929 tons were shipped by barge for delivery at upper Ohio River landings compared with 16,274 tons in 1933.

Notwithstanding the decreased demand for fluorspar in Illinois during 1934 considerable prospecting and development work were done, and improvements and additions were made to some mill flow sheets. The major development work at the Daisy mine consisted of sinking winze from the 600- to the 700-foot level and driving crosscuts and drifts. At the Spar Mountain mine two new and rather important ore bodies were discovered and partly drilled with a churn-type drill. Development work was carried on in No. 2 ore body through No. 2

shaft at the Victory mine. Continuation of the ore body to the northeast was proved by development work at the Crystal mine. The Cave in Rock mine, inactive for some time, was prospected and cleaned out. The mill serving the Spar Mountain mine was reconditioned completely, an additional mill of 150 tons capacity in 8 hours was built at the Victory mine, and some improvements were made at the mill serving the Dimick mine.

Cave in Rock district.[2]—The bedding deposits of the Cave in Rock district are mined at Spar Mountain and Lead Hill, about 4 miles northwest of Cave in Rock and 9 miles northeast of Rosiclare, the center of the vein mining industry in Illinois. When visited in July 1934 four companies were operating: Benzon Fluorspar Co., Victory Fluorspar Mining Co., and Crystal Fluorspar Co., on Spar Mountain, and Pittsburgh Fluorspar Products Corporation, on Lead Hill. There are several abandoned small mines and prospects scattered through the district.

Previous to 1919 little success had attended the exploitation of the bedding deposits, although some fluorspar had been produced at intervals from several small mines. Since that year, however, the Spar Mountain deposits have been persistently developed with increasing production. Under the economic conditions of the past 5 years the Cave in Rock district approached a controlling position in the fluorspar market because of the relatively low costs of mining, and the high grade of the run-of-mine product which requires only simple and inexpensive milling treatment.

The principal exploited bedding deposits occur chiefly on Spar Mountain, a broad, low, flat-topped mesalike prominence that rises about 240 feet above the north edge of a wide expanse of nearly level sink-hole country. A blufflike escarpment forms the southern and eastern borders of the prominence. A small nearly detached segment to the southwest is known as Lead Hill, in which several small mines and prospects have been intermittently operated.

The bedding deposits are flat-lying, somewhat elongated lenticular bodies of varying thicknesses. The ore bodies are generally connected or closely adjacent. A maximum thickness of 12 feet was observed, but the average mined thickness is about 4 feet.

The fluorspar of the bedding deposits is characteristically banded, due to replacement of the limestone country rock along beds of differing texture or composition. Bands of clear, pure, crystalline fluorspar alternate with less pure bands of finer texture. The pure bands usually show a comb structure, and in places are not completely filled. The bands of finer texture appear to faithfully preserve the texture and stratification of the original rock, but under the microscope are seen to be composed chiefly of fluorspar and, indeed, are commonly of sufficiently high purity so that the average content of coarse and fine bands runs well above the commercial limit for fluorspar content, and well below the limit for silica. The individual bands, both coarse and fine-textured, are usually from a quarter to an inch and a half in thickness, probably averaging one half to three quarters of an inch in the most typical, "coon-tail", spar. Since a separation of the materials of the alternating bands is not necessary in order to produce a high-grade fluxing spar, and since, in most of the ore bodies quartz and sulphides are present only in negligible amounts, the ores require very little milling.

The Cave in Rock mine, the several mines of Benzon Fluorspar Co., and the mine of Crystal Fluorspar Co. are situated along the escarpment through a distance of a mile and a quarter. These mines are entered and operated through adits. The Victory Fluorspar Mining Co. operates through two vertical shafts on the top of the mesa and the ore horizon is reached at a depth of 160 feet from the shaft collars. The properties of this company adjoin those of the Benzon Fluorspar Co. and Crystal Fluorspar Co. In all these mines the deposits are developed through drifts and rooms. The rooms and pillars are irregularly spaced, and, in general, development closely follows the ore bodies.

Developments and exploration to date on Spar Mountain indicate an area of about three fourths of a square mile underlain by discontinuous bedding deposits. The geologic features of the deposits and their relation to the regional geologic features suggest that a larger area to the north is worthy of prospecting as potentially productive territory, according to recent investigations carried on by the United States Geological Survey acting under the auspices of the Public Works Administration. Since the formations have a general regional dip to the north,

[2] Currier, L. W., Geologist, U. S. Geological Survey. (Published by permission of the Director, U. S. Geological Survey.)

the favorable horizon will be reached at greater depths, probably not to exceed 250 feet at a distance of about a mile from the escarpment. Prospecting in such areas must be done by drilling and the deposits developed through shafts.

Because of their mode of formation and their structural and stratigraphic relations, it is believed that bedding deposits may be wide-spread in the Illinois-Kentucky field, but further geologic work is necessary to indicate favorable areas. It is pertinent to note that specimens of the characteristic banded, or "coon-tail" fluorspar have been obtained from several places remote from the Cave in Rock district.

At present the known reserves of Cave in Rock ores appear to be comparatively small, although the area favorable to further prospecting and exploration is fairly large. The Cave in Rock district will doubtless continue to be an important producer for several years.

KENTUCKY

Much of the production of fluorspar in Kentucky in 1934 resulted from mining at a great many different properties by miners otherwise unemployed. Consequently, the number of mines or prospects worked increased from 41 in 1933 to 58 in 1934. In addition, a considerable tonnage of fluorspar was reclaimed from old storage yards, mill ponds, and waste dumps. The fluorspar from these sources apparently was reclaimed at comparatively low cost. For example, the fluorspar reclaimed from old storage yards required removal of only 1 or 2 feet of overburden and cleaning the material in washers. Fluorspar from old ponds, where mill waters had for many years deposited the fines, was reclaimed by means of washers and tables by cleaning the settlings which yielded a product that contained 80 to 88 percent calcium fluoride. Several old mine dumps were screened; the resultant product, which contained about 50 percent calcium fluoride and was low in silica, was mixed with high-grade fluorspar.

As a consequence, production of merchantable fluorspar in Kentucky increased from about 27,000 short tons in 1933 to about 48,000 tons in 1934, and shipments increased from 34,614 to 43,163 tons. Of the 1934 shipments, 7,373 tons were shipped by barge for delivery at upper Ohio River landings compared with 3,523 tons in 1933. The shipments by barge in 1934 were made from a loading station on the Ohio River near Casad and from stations on the Cumberland River at Pinckneyville and about 1 mile south of Mullikin.

Caldwell County.—Fluorspar mining in Caldwell County in 1934 was confined chiefly to the Hollowell & Hobby, Walker, and Tyrie mines. Production of merchantable fluorspar was about 2,600 tons in 1934 compared with 1,800 tons in 1933.

Crittenden County.—Increased output chiefly at the Lafayette, Watson (Eagle), and Bachelor mines and smaller increases at other mines, supplemented by much fluorspar mined at a great many different properties by miners otherwise unemployed and by fluorspar reclaimed from old storage yards, mill ponds, and waste dumps, resulted in a production of about 35,500 short tons of merchantable fluorspar in 1934 compared with 22,000 tons in 1933. About half the merchantable fluorspar mined in Crittenden County in 1934 came from 8 mines—Memphis, Brown, Loveless, Watson (Eagle), Lafayette, Two Brothers, Blue & Marble, and Bachelor; most of the remainder was produced at 33 mines or prospects, but a considerable tonnage was reclaimed from old storage yards, mill ponds, and waste dumps.

At the Lafayette mines, the largest producing unit in the western Kentucky field, development on the 250- and 400-foot levels and stoping above the 250-foot level continued until December 10, 1934, when active mine operations were suspended on account of the excessive supply of finished fluorspar on hand and the small demand for it. However, pumping is being continued. Developments are fully as favorable on the 400-foot level as on the 250-foot level.

A new ore body was being developed by a new 120-foot shaft at the Davenport mine.

Prospecting and development work were done at a great many other properties in Crittenden County during 1934 and two new mills—one to serve the Davenport mine and the other to serve the Watson (Eagle) mine—were installed.

Livingston County.—In Livingston County reopening of the Klondike mine (inactive since 1930) and the Nancy Hanks mine (idle in 1933), opening of several new mines including the Lola, Mineral Ridge (now John-Jim), Gossage, Green, and Mitchell mines, and output from the Bonanza, Hudson, and Split Nickel mines resulted in a production of 9,900 short tons of merchantable fluorspar in 1934, compared with 2,900 tons in 1933. The principal producing mine in Livingston County in 1934 was the Klondike, which was reopened in October and produced 3,700 tons of merchantable fluorspar.

NEVADA

Shipments of fluorspar from Nevada were 631 short tons in 1934 compared with 505 tons in 1933. Of the 1934 shipments 596 tons went to steel plants, 31 tons to cement plants, and 4 tons for miscellaneous uses.

The chief producing mine in Nevada in 1934 was the Baxter, 5½ miles from Broken Hills in Mineral County, which shipped 470 tons. The other active mine was the Daisy, 4½ miles southeast of Beatty in Nye County, which shipped 161 tons. A mill (at Beatty) serves the Daisy mine; it includes a grinding unit, and 4 tons of ground fluorspar were produced and shipped in 1934.

NEW HAMPSHIRE

Fluorspar mines near Westmoreland, Cheshire County (idle since 1923), were reopened during 1934, and a small quantity of ore was produced (but not shipped) in the late fall before cold weather interrupted further work. The fluorspar occurs in several veins, three of which were worked more or less extensively from 1911 to 1923 and yielded more than 7,000 tons of fluorspar. The country rock is highly siliceous schist or gneiss, but the fluorspar appears to be of a high degree of purity. On trial runs the ore mined in 1934 yielded jig concentrates containing 95 percent calcium fluoride and only 2.5 percent silica. Present plans anticipate production on a scale of around 2,000 tons annually, mostly for sale in New England which hitherto has been supplied mainly by imports.

NEW MEXICO

Shipments of fluorspar from New Mexico amounted to 2,040 short tons in 1934 compared with 994 tons in 1933 and consisted of 40 tons of metallurgical-gravel fluorspar and 2,000 tons of ground fluorspar.

Production of fluorspar in New Mexico in 1934 came chiefly from deposits near Deming in Luna County, but a little ore was mined near Mirage, also in Luna County, and near Derry and Hot Springs, both in Sierra County.

IMPORTS AND EXPORTS [3]

The total imports of fluorspar for consumption in the United States were 16,705 short tons (10,632 tons containing more than 97 percent and 6,073 tons containing not more than 97 percent calcium fluoride) valued [4] at $183,286 in 1934 compared with 10,398 tons (5,203 tons containing more than 97 percent and 5,195 tons containing not more than 97 percent calcium fluoride) valued [4] at $105,301 in 1933. The value assigned to the foreign fluorspar in 1934 averaged $10.97 a ton. The cost to consumers in the United States includes, in addition, the duty, loading charges at the docks, ocean freight, insurance, consular fee, and freight from docks to manufacturers' plants.

Of the imports in 1934 about 35 percent was metallurgical-gravel fluorspar, 11 percent ceramic-ground fluorspar, and 54 percent acid (chiefly lump) fluorspar. The metallurgical-gravel fluorspar was imported chiefly from Spain, followed in order by Germany, Newfoundland, United Kingdom, and China; the ceramic-ground fluorspar was imported chiefly from Germany, followed by Spain, Italy, and China; and the acid-grade fluorspar was imported chiefly from Germany, followed by the Union of South Africa, Newfoundland, and Spain. The imported fluorspar credited to Canada in 1934 in the two following tables apparently was produced in Newfoundland.

The imports were equivalent to 19 percent of the total shipments of domestic fluorspar in 1934 compared with 14 percent in 1933.

Fluorspar imported into the United States, 1933–34, by countries [1]

Country	Containing more than 97 percent calcium fluoride		Containing not more than 97 percent calcium fluoride		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1933						
China	27	$413			27	$413
France			204	$1,247	204	1,247
Germany	3,773	51,585	560	3,251	4,333	54,836
Italy			533	4,533	533	4,533
Newfoundland			[2] 320	2,646	[2] 320	2,646
Spain	635	8,728	3,627	19,962	4,262	28,690
Union of South Africa	712	12,449			712	12,449
United Kingdom	17	229			17	229
	5,164	73,404	5,244	31,639	10,408	105,043
1934 [1]						
Canada			187	2,962	187	2,962
China	2	31	110	959	112	990
Germany	7,518	94,291	706	4,274	8,224	98,565
Italy			60	587	60	587
Newfoundland	297	6,460	448	4,000	745	10,460
Spain	818	12,800	4,096	22,516	4,914	35,316
Union of South Africa	1,997	31,872			1,997	31,872
United Kingdom			466	2,534	466	2,534
	10,632	145,454	6,073	37,832	16,705	183,286

[1] Data on total imports in 1934 and 1933 are not strictly comparable due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

[2] Quantity reported to the Bureau of Mines by the importer; Bureau of Foreign and Domestic Commerce records 560 short tons valued at $3,500.

[3] Figures on imports (unless otherwise indicated) compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce; those on exports supplied by the producers. No exports of fluorspar recorded by the Bureau of Foreign and Domestic Commerce.

[4] As defined in sec. 402 of the Tariff Act of 1930, "The value of imported merchandise * * * is the foreign value or the export value, whichever is higher—that is, the market value or the price at which the merchandise, at the time of exportation to the United States, is offered for sale in the principal markets of the country from which exported, including the cost of containers or coverings and all expenses (including any export tax) incident to placing the merchandise in condition ready for shipment to the United States."

Fluorspar imported into the United States, 1930–34, by countries [1]

Year	Africa		Canada		France		Germany		Italy	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	2,712	$31,069			23,313	$184,238	23,797	$189,587	1,802	$17,198
1931	3,672	40,375	280	$2,313	4,462	33,646	6,491	77,067	1,523	24,267
1932	1,587	14,809			1,578	9,588	5,842	70,294	1,457	11,848
1933	712	12,449			204	1,247	4,333	54,836	533	4,533
1934 [1]	1,997	31,872	187	2,962			8,224	98,565	60	587

Year	Spain		United Kingdom		All other		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	6,784	$53,612	5,756	$60,995	739	$7,957	64,903	$544,656
1931	4,068	31,786			213	1,981	20,709	211,435
1932	2,659	24,881	1	378	112	867	13,236	132,665
1933	4,262	28,690	17	229	[2] 347	3,059	10,408	105,043
1934 [1]	4,914	35,316	466	2,534	857	11,450	16,705	183,286

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas total imports for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

[2] Includes imports (320 short tons) reported to the Bureau of Mines by the importer; Bureau of Foreign and Domestic Commerce records 560 short tons valued at $3,500 from Newfoundland.

The following table, compiled from data courteously furnished the Bureau of Mines by importers, shows the quantities of imported fluorspar delivered to consumers in the United States in 1933 and 1934 and the selling price at tidewater (duty paid) irrespective of year of importation into the United States; it differs from the preceding tables which show the quantities received in the United States during 1933 and 1934. The quantities in this table are based on the actual outturn weight ascertained by sworn weighers and represent the weight on which duty was paid and the entries were liquidated.

Imported fluorspar delivered to consumers in the United States, 1933–34

Industry	1933			1934		
	Short tons	Selling price at tidewater, including duty		Short tons	Selling price at tidewater, including duty	
		Total	Average		Total	Average
Steel	6,208	$105,800	$17.04	5,394	$100,830	$18.69
Glass	1,288	33,160	25.75	1,257	36,120	28.74
Enamel	939	24,953	26.57	583	17,324	29.72
Hydrofluoric acid	3,971	90,313	22.74	8,982	217,650	24.23
Cement				182	4,100	22.53
	12,406	254,226	20.49	16,398	376,024	22.93

Manufacturers of glass and enamel purchased a smaller proportion of their fluorspar supply from importers in 1934 than in 1933. For example, in 1934 such manufacturers purchased 1,840 short tons from importers and 9,933 tons from domestic producers, whereas in 1933 their purchases were 2,227 and 9,878 tons, respectively. In 1934, as in 1933, most of the acid-grade fluorspar purchased was supplied by importers, who sold 8,982 tons compared with 1,666 tons sold by domestic producers.

Producers of fluorspar reported exports of 522 short tons valued at $8,602 in 1934 compared with 71 tons valued at $967 in 1933. In 1934, 491 tons were exported to Canada and 31 tons to Peru; in 1933 all the fluorspar exported went to Canada.

Fluorspar reported by producers as exported from the United States, 1930–34

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1930	281	$6,160	$21.92	1933	71	$967	$13.62
1931	311	5,599	18.00	1934	522	8,602	16.48
1932	25	553	22.12				

FLUORSPAR IN FOREIGN COUNTRIES

CANADA [5]

The production of fluorspar in Canada was 150 short tons valued at $2,100 in 1934 compared with 73 tons valued at $1,064 in 1933. The output in both years was from Hastings County, Ontario.

Imports of fluorspar into Canada were 7,220 short tons valued at $56,628 in 1934 compared with 2,219 tons valued at $21,165 in 1933.

NEWFOUNDLAND

The deposits of fluorspar in the Districts of Burin East and Burin West, Newfoundland, at which mining was begun in 1933, shipped 2,794 short tons of fluorspar in 1934, compared with about 1,600 tons in 1933. Shipments in 1934 consisted of 1,288 short tons of fluxing-grade fluorspar for use in steel plants, 1,204 tons containing 93 to 95 percent calcium fluoride, and 302 tons of acid-grade fluorspar, of which all the acid grade and 575 tons of the fluxing grade were exported to the United States.

UNION OF SOUTH AFRICA

According to Day,[6] acid-grade gravel fluorspar, reported as containing a minimum of 98 percent calcium fluoride and a maximum of 1 percent silica, is being produced in the Union of South Africa by flotation and ground.

[5] Data from Dominion Bureau of Statistics, Preliminary Report on the Mineral Production of Canada during the Calendar Year 1934: Ottawa, 1935, p. 33.

[6] Day, S. D. (American commercial attaché, Johannesburg, South Africa), Trade Opportunities for Purchase of Acid Fluorspar: Bur. For. and Dom. Com., Foreign Trade Notes—Minerals, vol. 4, no. 2, Washington, 1935, p. 8.

U. S. S. R. (RUSSIA) [7]

There are a number of deposits of fluorspar in the Soviet Union, such, for example, as at Solnechny in Transbaikalia and at Aurakhmat in Central Asia, but all are far from railroad transportation; therefore, because of the long and expensive haul to the Urals, the Donets Basin, and Karelia, where this material is used as a flux in metallurgy, only small quantities—some 20,000 metric tons a year—have been utilized. Meanwhile, the construction of steel mills and aluminum plants increases the demand for fluorspar.

Consequently, the discovery of a new, large fluorspar deposit is of great importance. The one recently explored is on the shore of the Kara Sea in a mineralized zone extending over a large area, including the mainland and Novaya Zemlia, where lead, zinc, copper, iron pyrites, and other minerals have been found. Prospecting in 1933 disclosed the presence of large quantities of pure-white fluorspar along the Amderma River, which runs north into the Kara Sea. The veins range from 1.5 to 7 meters (4.9 to 23 feet) thick, and there are also pockets and lenses of varying sizes. Fluorspar containing 23 to 58 percent calcium fluoride also is found in combination with other minerals. It is estimated that the reserves of the areas already charted total about 1,000,000 tons of high quality; 3,300 tons tested in a chemical laboratory yielded 2,500 tons containing 97.7 to 99.3 percent calcium fluoride and 800 tons containing 92.6 to 97.7 percent calcium fluoride. The quartz content ranges from almost zero to 2 or 3 percent. Applying the German standards for fluorspar, 75 percent of this deposit would be classed as the highest grade. It resembles the mines in Illinois and Kentucky but averages higher in grade. It is the purest found so far in the U. S. S. R. (Russia).

It is proposed to run a 25-kilometer (15.5-mile) narrow-gage railroad from the mines to the shore, where the fluorspar can be loaded on ships for a 4-day run to Archangel.

A little over 100 kilometers (62 miles) from Amderma on the Kara River deposits of iron pyrites have been located. In the vicinity are the Vorkuta coking coal fields, and the question is being discussed of erecting a cryolite plant to use local raw materials and export artificial cryolite and other fluorine salts.

[7] Bureau of Foreign and Domestic Commerce, Discovery of Fluorspar Deposit: Russian Econ. Notes, no. 278, Washington, July 30, 1934, p. 9.

WORLD PRODUCTION

World production of fluorspar, 1930–34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1930	1931	1932	1933	1934
Argentina			10	200	(1)
Australia:					
New South Wales	205	12		51	(1)
Queensland	763	529	1,240	749	(1)
South Australia			41	201	(1)
Canada	73	36	29	66	136
Chosen	2,297	2,648	7,577	9,076	(1)
France	58,660	23,800	(1)	(1)	(1)
Germany: [2]					
Bavaria	48,063	26,780	21,915	(1)	(1)
Prussia	30,272	12,842	7,794	10,653	(1)
Saxony	11,871	6,937	2,656	(1)	(1)
Great Britain	30,266	20,242	15,675	28,508	(1)
Italy	6,655	5,850	6,450	7,714	(1)
Newfoundland				1,930	2,134
Norway	821	630	571	(1)	(1)
South-West Africa			610		(1)
Spain	11,296	6,017	7,018	3,564	(1)
Switzerland [3]	1,000	1,000	1,000	1,000	1,000
Union of South Africa	1,520	2,197	1,317	445	1,393
United States	86,952	48,520	22,907	66,161	77,823

[1] Data not available.
[2] In addition to the German States listed fluorspar is produced in Baden and Thuringia, but data of output are not available.
[3] Estimated annual production.

CRYOLITE

Cryolite occurs in commercial quantity and is mined at only one place—Ivigtut, Greenland. The greater part of the product is shipped to Copenhagen; the remainder is exported to the United States, from which country some is reexported to Canada.

The ore shipped to the United States ranges from approximately 70 percent to over 90 percent pure cryolite. The ores, of varying gradations of purity, generally are mixed in shipment; except in rare instances, the material is run through the purification plant as it is received. The method of purification consists essentially of a series of magnets, tables, jigs, and flotation.

The purified cryolite is used chiefly in the metallurgy of aluminum and in making opaque glass. A considerable quantity of ground cryolite is being used in insecticides. Although fine cryolite resulting from the purification process has been so used for many years, an efficient method of grinding cryolite to a fineness that would permit its use for insecticides was discovered only recently.

According to the Bureau of Foreign and Domestic Commerce the United States imported 4,450 long tons of cryolite valued at $376,868 in 1934 compared with 4,141 long tons valued at $298,316 in 1933.

FELDSPAR

By R. W. Metcalf

SUMMARY OUTLINE

The output of crude feldspar in the United States in 1934 was 154,188 long tons, an increase of 2.4 percent over 1933. The average value per ton, reflecting the higher prices obtained for crude under the code, advanced from $5.17 in 1933 to $5.53 in 1934, while the

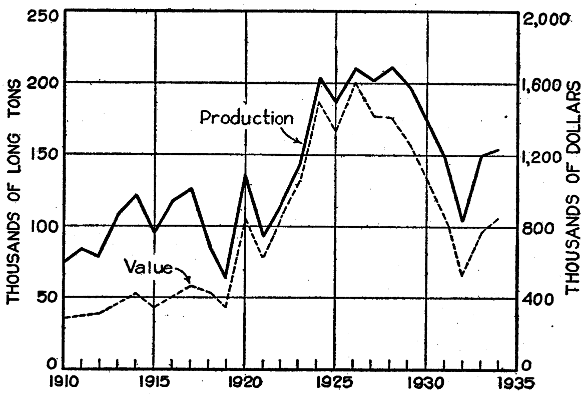

FIGURE 118.—Trends in production and value of crude feldspar in the United States, 1910–34.

total value of the crude spar produced increased 9.5 percent to $853,136. Trends in production and value of crude feldspar since 1910 are shown in figure 118.

The larger production of feldspar in 1934 was due principally to expanded output in the smaller producing States, as production declined in 3 of the 4 principal producing States. Output in North Carolina declined 7 percent, in Virginia 10 percent, and in New Hampshire 2.5 percent, whereas production in Maine increased 30 percent. South Dakota gained nearly 6,000 tons, the largest tonnage and percentage increase of any State.

The tonnage of domestic feldspar ground by merchant mills in 1934 showed a greater increase over 1933 than the output of crude spar mined, indicating withdrawals of stocks of crude accumulated at mills during 1933. Total sales of ground feldspar by merchant mills in 1934 were 144,178 short tons valued at $1,868,500, an increase of 8.4 percent in tonnage and 15.5 percent in value compared with 1933. The average value per ton of domestic ground spar increased from $11.80 per short ton in 1933 to $12.66 in 1934. The average value of Canadian spar, although considerably higher than that of the domestic product, dropped from $19.07 in 1933 to $18.62 in 1934.

Salient statistics of the feldspar industry in the United States, 1933–34

	1933	1934	Percent of change in 1934
Crude feldspar sold or used by producers:			
Long tons	150,633	154,188	+2.4
Value	$778,826	$853,136	+9.5
Average per long ton	$5.17	$5.53	+7.0
Ground feldspar sold by merchant mills:			
Short tons	133,008	144,178	+8.4
Value	$1,617,552	$1,868,500	+15.5
Domestic:			
Short tons	126,418	136,820	+8.2
Value	$1,491,904	$1,731,528	+16.1
Average per short ton	$11.80	$12.66	+7.3
Canadian:			
Short tons	6,590	7,358	+11.7
Value	$125,648	$136,972	+9.0
Average per short ton	$19.07	$18.62	−2.4
Feldspar imported for consumption:			
Crude:			
Long tons	3,239	9,744	+200.8
Value	$21,877	$67,258	+207.4
Ground:			
Short tons	30		
Value	$242		

Uses.—Feldspar is used chiefly in the ceramic industry. More than half the ground spar is used in glass manufacture, where it is employed primarily as a source of alumina but also contains other valuable ingredients, such as soda and potash. Because of these constituents it melts without becoming entirely fluid and when cool forms a strong, colorless, or only slightly colored glass. A large proportion of the output commonly is consumed in the manufacture of brick, tile, pottery, and enameled and sanitary ware. In most forms of pottery, feldspar is an essential ingredient of both the body and the glaze. Electrical insulators and other electrical porcelain goods contain feldspar, as well as soap and abrasives. Producers accounting for 73 percent of ground-spar sales in 1934 reported uses for which their material was sold. These data are summarized in the accompanying table:

Ground feldspar sold by merchant mills in the United States in 1934, by uses [1]

Use	Short tons	Percent of total	Use	Short tons	Percent of total
Glass	56,726	53.9	Other ceramic uses	87	0.1
Pottery	28,689	27.3	Soaps and abrasives	1,015	.9
Enamel and sanitary ware	9,643	9.2	Binder for abrasive wheels	1,027	1.0
Insulators and other porcelain goods	5,346	5.1	Other uses	211	.2
Brick and tile	2,447	2.3		[1] 105,191	100.0

[1] Covers 73 percent of the total ground spar sold by merchant mills in the United States; data by uses not available for the other 27 percent.

Market conditions.—The market for feldspar in 1934, as evidenced by the trends of activity in industries consuming large quantities of feldspar, exhibited mixed tendencies. Shipments of bathroom sanitary accessories were slightly less than in 1933, following closely the value of residential contracts awarded, as reported by F. W. Dodge Corporation. The value of total electrical porcelain shipments also was somewhat less than in 1933. Shipments of vitreous china plumbing fixtures and porcelain plumbing fixtures declined 12.9 percent and 10.9 percent, respectively, from the 1933 level. The value of porcelain enameled flatware and shipments of illuminating glassware, however, increased sharply. Glass-container shipments in 1934 were 6 percent higher than in 1933.

Capacity.—The feldspar industry maintains grinding equipment greatly in excess of that required to supply current demands. This condition has been apparent for many years. Even in 1929 mills were operated at only about 28 percent of capacity, and in 1933 the industry was operating at approximately 13 percent of capacity, according to the Administrator's report to the President [1] dated January 16, 1934, approving the code of fair competition for the feldspar industry. Producers of ground spar were requested to give the capacity of their mills in 1934, that is, the number of short tons of ground feldspar which could have been produced during the year, working the usual number of hours a day, assuming a continuous demand and allowing for unavoidable shut-downs for repairs or other unforeseen delays. Mills producing 91,754 short tons, or about 64 percent of the total output of ground spar in the United States in 1934, reported a capacity of 270,400 short tons, which indicated an approximate total capacity of grinding equipment in the industry of 420,000 short tons.

Prices.—Increased prices authorized under the code were reflected in the April quotations of commercial grades of Maine and North Carolina feldspar, as reported in Metal and Mineral Markets, but prices of Virginia spars did not change until May and June. North Carolina granular glass spar, 20-mesh, quoted in January at $10.50 per ton advanced to $11.50 in April. Potash spar, f. o. b. North Carolina, rose from $15 in March to $17 in April, while soda spar, also from North Carolina, increased $2 a ton in April to $19 per ton. Quoted prices on North Carolina spar then remained unchanged during the rest of the year. Quotations on Maine white potash spar, 200-mesh, although increasing $1.50 to $17 per ton in April, averaged only $16.62 per ton in 1934 compared with $16.79 per ton in 1933. Virginia No. 1, 200-mesh grade, was quoted at $16.50 until May, when it rose to $17, with an average for 1934 of $16.79 compared with $15.92 in 1933. Quoted prices on No. 1 glassmakers' spar advanced from $10.50 for January through May to $10.75 for the rest of the year. Quotations on enamelers' spar, which had averaged $14 per ton, f. o. b. Virginia, during most of 1933, rose to $14.50 in June 1934 and to $15 in July.

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[1] National Recovery Administration, Code of Fair Competition for the Feldspar Industry: Approved Code no. 206, p. 155.

REVIEW OF INDUSTRY BY STATES

The term "crude feldspar" is applied to the lump spar shipped from the mine or quarry contrasted with ground spar, the finished product of the crushing and pulverizing equipment. Statistics of production are presented separately for crude and ground spar; in accordance with the usual practice in the industry the crude is reported in long tons of 2,240 pounds and the ground in short tons of 2,000 pounds.

In years of normal business activity the quantity of ground spar produced from domestic crude averages about 87 percent of the crude output; the remaining 13 percent includes spar used for purposes not requiring fine grinding and that lost or discarded during grinding. Sales of ground domestic spar were only 75 percent of the total crude output in 1933 and 79 percent in 1934 thus indicating either accumulation of large stocks of spar at the grinding mills or increased use of unground spar.

Crude feldspar.—Crude feldspar sold or used by producers in the United States in 1934 totaled 154,188 long tons valued at $853,136, an increase of 2.4 percent in quantity and 9.5 percent in value compared with 1933. The average value of crude spar at the mine or shipping point in 1934 was $5.53, an increase of 36 cents or 7 percent over the 1933 realization of $5.17. The average value of crude feldspar as reported by individual producers ranged from $2.63 to $10.64 a long ton. For New England the value ranged from $3.50 to $9; for New York, Pennsylvania, and Virginia, from $5.07 to $10.64; for North Carolina, from $5.50 to $6.79; and for the Western States, from $2.63 to $7.98.

Crude feldspar sold or used by producers in the United States, 1929–34

Year	Long tons	Value		Year	Long tons	Value	
		Total	Average			Total	Average
1929	197,699	$1,276,640	$6.46	1932	104,715	$539,641	$5.15
1930	171,788	1,066,636	6.21	1933	150,633	778,826	5.17
1931	147,119	861,059	5.85	1934	154,188	853,136	5.53

Crude feldspar was produced in 13 States in 1934, 1 more than in 1933; Maryland and Nevada reported small outputs, but Minnesota did not produce in 1934. North Carolina, with an output of 79,844 long tons (7.1 percent less than in 1933) accounted for 52 percent of the total and produced more than 5 times as much spar as any other State. Maine jumped from fourth place in 1933 to second in 1934 with an output of 14,685 tons. Virginia with 12,140 tons ranked third, followed closely by New Hampshire with 12,119 tons. The other producing States, in order of production, were Colorado, South Dakota, New York, Arizona, Connecticut, California, Maryland, Pennsylvania, and Nevada.

Virtually all the smaller producing States made substantial increases in output in 1934 compared with 1933, while there were decreases of 7.1 percent for North Carolina, 9.8 percent for Virginia, and 2.5 percent for New Hampshire. Increased activity resulted in nearly tripling production in South Dakota, and the output in Maine was 30 percent greater than in 1933.

Crude feldspar sold or used by producers in the United States, 1932–34, by States

[Value is at mine or nearest shipping point]

State	1932		1933		1934	
	Long tons	Value	Long tons	Value	Long tons	Value
Arizona	1,232	$4,496	(1)	(1)	(1)	(1)
California	(1)	(1)	1,433	$10,189	(1)	(1)
Colorado	5,612	20,304	(1)	(1)	(1)	(1)
Connecticut	(1)	(1)	(1)	(1)	(1)	(1)
Maine	8,345	41,874	11,273	48,380	14,685	$82,854
Maryland	90	1,157			(1)	(1)
Minnesota	(1)	(1)	(1)	(1)		
Nevada	50	300			(1)	(1)
New Hampshire	8,718	61,416	12,425	82,978	12,119	80,733
New York	6,255	34,705	6,138	41,736	6,262	37,275
North Carolina	58,465	300,877	85,962	471,312	79,844	465,214
Pennsylvania	25	171	213	1,442	64	456
South Dakota	6,067	22,256	3,220	12,058	9,190	30,892
Virginia	6,759	31,990	13,459	52,758	12,140	64,529
Undistributed	3,097	20,095	16,510	57,973	19,884	91,183
	104,715	539,641	150,633	778,826	154,188	853,136

[1] Included under "Undistributed."

Ground feldspar.—Almost all the feldspar consumed industrially is prepared by fine grinding. Even that used for facing cement blocks, for covering prepared roofing, and for similar purposes is crushed to small sizes and more or less graded by screening. It has not been practicable to canvass all consumers of feldspar to determine the quantities used by them, but all known merchant mills or grinders—that is, those that quarry or purchase crude spar and grind it for sale to other establishments—have been canvassed during recent years.

Ground feldspar sold by merchant mills in 1934 totaled 144,178 short tons valued at $1,868,500, an increase of 8.4 percent in tonnage and 15.5 percent in value compared with 1933. In 1934 there were 26 active mills operated by 20 producing companies in 14 States. Domestic spar was handled exclusively by 22 mills and imported (Canadian) spar exclusively by 3 mills, while 1 mill ground both imported (Canadian) and domestic material. Approximately 95 percent of total quantity ground in both 1934 and 1933 was domestic spar and 5 percent Canadian spar.

Ground feldspar sold by merchant mills [1] in the United States, 1929–34

Year	Number of active mills	Domestic			Canadian			Total	
		Short tons	Value		Short tons	Value		Short tons	Value
			Total	Average		Total	Average		
1929	33	209,808	$2,880,824	$13.73	20,774	$415,428	$20.00	230,582	$3,296,252
1930	34	167,380	2,167,352	12.95	14,161	283,563	20.02	118,541	2,450,915
1931	29	132,542	1,630,917	12.30	11,382	222,476	19.55	143,924	1,853,393
1932	27	104,289	1,174,833	11.27	3,460	65,659	18.98	107,749	1,240,492
1933	25	126,418	1,491,904	11.80	6,590	125,648	19.07	133,008	1,617,552
1934	26	136,820	1,731,528	12.66	7,358	136,972	18.62	144,178	1,868,500

[1] Does not include potters or others who grind for consumption in their own plants.

The average value of the ground feldspar from domestic crude in 1934 was $12.66, an increase of 86 cents (7.3 percent) over 1933; the average value reported for the various States ranged from $7.72 to $20.56 per ton. Ground feldspar from imported crude in 1934 averaged $18.62—45 cents less than in 1933.

Ground feldspar sold by merchant mills [1] in the United States, 1933–34, by States

State	1933					1934				
	Number of active mills	Domestic		Canadian		Number of active mills	Domestic		Canadian	
		Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
California	1	1,312	$17,227			1	(2)	(2)		
Colorado	1	10,300	79,310			1	12,417	$95,858		
Maine	3	9,492	129,259			3	8,979	136,672		
New Hampshire	1	5,873	76,102			1	6,565	83,470		
New Jersey	3	9,365	164,932			3	8,416	165,980		
New York	4	(2)	(2)	6,495	$123,689	4	(2)	(2)	6,579	$125,572
Ohio	2	(2)	(2)	95	1,959	2	(2)	(2)	(2)	(2)
North Carolina	4	} 63,074	707,667			4	} 67,497	847,835		
Tennessee	1					1				
Undistributed [3]	5	27,002	317,407			6	32,946	401,713	779	11,400
	25	126,418	1,491,904	6,590	125,648	26	136,820	1,731,528	7,358	136,972

[1] Does not include potters or others who grind for consumption in their own plants.
[2] Included under "Undistributed."
[3] 1933: Arizona, Illinois, Minnesota, New York, Ohio, South Dakota, and Virginia; 1934: Arizona, California, Illinois, Minnesota, New York, Ohio, South Dakota, and Virginia.

North Carolina was the largest producer of ground feldspar, followed by Tennessee and Colorado. As in 1933, these three States produced 55 percent of the total; the other producing States in order were New York, Virginia, Maine, New Jersey, South Dakota, New Hampshire, Arizona, and Ohio, with smaller tonnages from Illinois, California, and Minnesota.

Production of ground feldspar in 1934 showed pronounced gains over 1933 in Arizona, Colorado, Illinois, New Hampshire, North Carolina, Ohio, South Dakota, and Virginia, but the output from Maine, California, New Jersey, and New York was less than in 1933.

Imports.[2]—Imports of crude feldspar for consumption again increased sharply, rising in 1934 to 9,744 long tons valued at $67,258, compared with 3,239 tons valued at $21,877 in 1933. All imports of crude spar in 1934 were from Canada, except 100 tons valued at $824 from Sweden.

No ground feldspar was imported in 1934 and only 30 short tons, valued at $242, in 1933.

[2] Figures on imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau o Foreign and Domestic Commerce.

Feldspar imported for consumption in the United States, 1929-34

Year	Crude		Crushed or ground		Year	Crude		Crushed or ground	
	Long tons	Value	Short tons	Value		Long tons	Value	Short tons	Value
1929	29,927	$241,852	3	$131	1932	1,872	$14,346	28	$218
1930	21,006	167,157	57	586	1933	3,239	21,877	30	242
1931	10,719	95,096	79	1,500	1934	9,744	67,258		

Cornwall stone.—Imports of Cornwall stone in 1934 dropped to 10 short tons, valued at $143. Complete statistics covering imports of Cornwall stone have not been available, and additional material may enter the United States designated as feldspar, flint, china clay, or other similar products.

However, of more significance are reported discoveries of domestic sources of materials of similar origin and chemical composition, notably in North Carolina and California, which may indicate even further curtailed use of imported Cornwall stone in future years.

WORLD PRODUCTION

The following table shows the most recent figures available on output of feldspar in the chief producing countries. Aside from the United States and Canada the most important countries are Czechoslovakia, Norway, and Sweden. Production of feldspar in Canada was 15,726 metric tons, an increase of 63 percent over 1933. Virtually all of this increased output was shipped to the United States for grinding.

World production of feldspar, 1930-34, by countries, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
Argentina (shipments)	196	172	369	376	(2)
Australia:					
New South Wales [3]	86	103	590	2,037	(2)
South Australia [3]			65	112	(2)
Western Austrlia (exports)		106	367	460	(2)
Canada (shipments)	24,309	16,640	6,393	9,669	15,726
Egypt		26	179	60	(2)
Finland (exports)	620	67	1,529	2,706	(2)
France	12,800	10,700	(2)	(2)	(2)
Germany (Bavaria)	5,150	5,000	3,550	(2)	(2)
India (British)		339	481	688	(2)
Italy	5,750	4,750	5,217	4,861	(2)
Norway (exports)	19,922	15,105	13,015	17,986	(2)
Rumania	1,963	3,068	681	1,309	(2)
Sweden	38,596	33,113	23,693	32,567	(2)
United States (shipments)	174,545	149,480	106,396	153,051	156,663

[1] In addition to countries listed, feldspar is produced in Czechoslovakia. Official figures of output are not available, but it is estimated that the annual production is approximately 30,000 metric tons. (Stat. Com. Czechoslovak Ceram., Soc.)
[2] Data not available.
[3] Includes some china stone.

ASBESTOS

By Oliver Bowles and B. H. Stoddard

SUMMARY OUTLINE

Asbestos is of two main types—spinning and nonspinning—which enter entirely different fields of utilization. Spinning fiber is used for fabrics and packings, principally automobile brake-band linings. Nonspinning fiber is consumed mainly by the building trades; the longer material is employed for asbestos paper, asbestos-cement shingles, and millboard and the shorter for asbestos cement, which in turn is used for pipe and boiler covering. Increasing quantities of the better grades of nonspinning fiber are used for molded brake linings of automobiles. Varieties, properties, occurrences, uses, and various other features of asbestos are discussed fully in a recent publication.[1]

Although the United States is the world's largest manufacturer of asbestos products, it supplies only 2 to 4 percent of its own requirements of raw material. Arizona produces some high-grade spinning fiber; Vermont provides considerable shorter fiber; Maryland furnishes a high-grade filter asbestos; and Montana, Georgia, and North Carolina occasionally produce amphibole (anthophyllite). The United States depends mainly upon Canada for its supply of nonspinning fiber and upon South Africa, Canada, and Russia for nearly all of its spinning material.

Salient statistics of the asbestos industry in the United States, 1933–34

	1933		1934	
	Short tons	Value	Short tons	Value
Domestic asbestos (chrysotile and amphibole)[1]—				
Produced	5,017	(2)	6,544	(2)
Sold or used by producers	4,745	$130,677	5,087	$158,347
Imports (unmanufactured)	119,542	3,542,483	120,334	3,377,994
Exports (unmanufactured)	1,378	88,521	1,669	94,182
Apparent consumption	122,909	3,584,639	123,752	3,442,159
Exports of asbestos products	(2)	1,743,140	(2)	2,142,514

[1] Bureau of Mines not at liberty to publish figures separately for chrysotile and amphibole.
[2] Figures not available.

[1] Bowles, Oliver, Asbestos—General Information: Inf. Circ. 6817, Bureau of Mines, 1935, 21 pp.

Domestic production of asbestos amounted to 6,544 short tons in 1934 compared with 5,017 tons in 1933, an increase of 30 percent. The quantity sold or used by producers in 1934 (5,087 tons, valued at $158,347) increased 7 percent in quantity and 21 percent in value over 1933. Only about 4 percent of the raw material used was mined in this country. Compared with 1933 the apparent consumption of asbestos in 1934 increased less than 1 percent in quantity, but the value of the material consumed declined. The value of exports of asbestos products increased 23 percent.

The data on total imports in 1934 and 1933 may not be strictly comparable due to the change by the Bureau of Foreign and Domestic Commerce in reporting statistics—from "general imports" in 1933 and earlier years to "imports for consumption" in 1934; however, this change has little effect on figures for nondutiable commodities such as unmanufactured asbestos.

Consumption trends.—The following table of apparent consumption of raw asbestos, value of products manufactured, and value of products exported shows major trends in recent years. Apparent consumption is determined by adding imports to domestic asbestos sold or used by producers and subtracting exports. No data are available to make adjustments for variation in consumers' stocks.

Raw asbestos consumed in the United States and asbestos products manufactured in and exported from the United States, 1925–34

Year	Raw asbestos—apparent consumption	Asbestos products: Manufactured [1] (value)	Asbestos products: Exported (value)	Year	Raw asbestos—apparent consumption	Asbestos products: Manufactured [1] (value)	Asbestos products: Exported (value)
	Short tons				*Short tons*		
1925	230,669	(2)	$2,383,325	1930	212,152	(1)	$4,193,510
1926	257,875	(1)	3,481,814	1931	137,875	$56,164,690	2,606,166
1927	226,365	(2)	2,687,086	1932	98,606	(1)	1,608,880
1928	231,984	(1)	3,999,022	1933	122,909	41,598,866	1,743,140
1929	264,873	$95,773,414	4,640,599	1934	123,752	(1)	2,142,514

1 Figures of Bureau of the Census (collected biennially for odd years) include value of certain gaskets, packing, and similar products in which little asbestos was employed.
2 Comparable figures not available prior to 1929.

Figure 119 illustrates the close relationship between activity in the building and automobile industries and the quantity of asbestos consumed in the United States. During the years when the spread between building contracts and automobile production was greatest asbestos consumption followed an intermediate course. From 1929 to 1932, when activity in the two principal consuming industries declined most seriously, asbestos consumption also decreased, although the relative decline was less precipitous, probably due to the repair of buildings and relining of brakes during the depression. The substantial gain in consumption of asbestos in 1933 was retarded in 1934 by the continued depression in building.

Market conditions.—The demand for asbestos for heat insulation and the manufacture of building materials was weak in 1934, because construction remained at an unusually low level. On the other hand, the demand for brake-band linings and clutch facings improved considerably because of an increase of about 45 percent in the number of automobiles and trucks manufactured in the United States and Canada in 1934 compared with 1933.

Prices.—Price quotations as given in Metal and Mineral Markets were uniform throughout 1934 for all grades of asbestos except material from the U. S. S. R. Russian Crude No. 2 was quoted at $150 a ton, c. i. f. New York, in January 1934 and $160 to $165 in December, and Crude No. 3 at $125 a ton in January and $125 to

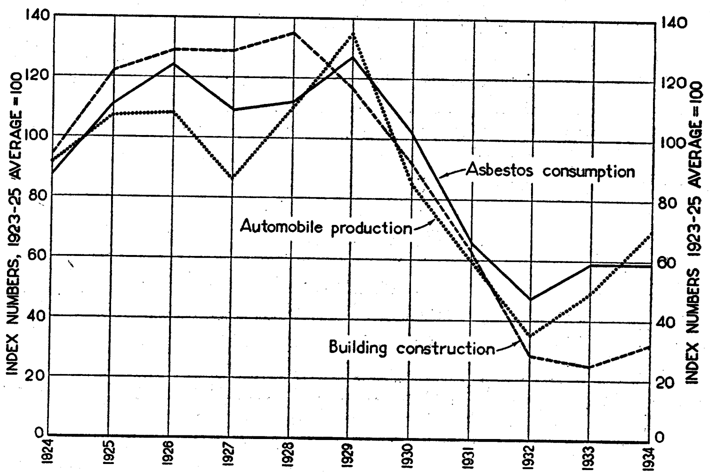

FIGURE 119.—Asbestos consumption compared with automobile production and building construction, 1924–34. Unlike units are reduced to percentages of the 1923–25 average. Statistics of asbestos are from the Bureau of Mines, automobiles from the U. S. Bureau of the Census, and building contracts from the Federal Reserve Board.

$135 in December. The following table shows the quotations in 1934 for asbestos other than Russian.

Price quotations for asbestos (other than Russian) per short ton in 1934 [1]

Grade	Price	Grade	Price
Canadian:		Rhodesian:	
Crude No. 1	$450	Crude No. 1	$210
Crude No. 2	$200–225	Crude No. 2	160
Spinning fiber	90–135	Vermont:	
Magnesia and compressed sheet fibers	90–100	Shingle stock	45
Shingle stock	45–65	Paper stock	35
Paper stock	32.50–37.50	Cement stock	23
Cement stock	19–23		
Floats	16–18.50		

[1] Prices quoted as follows: Canadian, f. o. b. Quebec mines; Rhodesian, c. i. f. New York; Vermont, f. o. b. mines, Vermont.

New developments.—Germany has made some progress toward developing a synthetic amphibole asbestos similar to hornblende. The material evidently is designed to replace short-fibered asbestos only, but no information is available yet on the products for which it is best suited.[2] Improvements have been made in asbestos brake linings, packings, and paper and in asbestos-cement conduits.

[2] U. S. Bureau of Foreign and Domestic Commerce, Foreign Trade Notes—Minerals and Metals: Vol. 3 Oct. 27, 1934, p. 4.

An important event in 1934 was the acquisition by Turner & Newall, Ltd., Rochdale, England, of the controlling interest in Keasbey & Mattison Co., Ambler, Pa. As the latter company owns the Bell mine in Quebec, the British firm not only has extended its manufacturing activities in the United States but also has become a producer of raw asbestos in Canada. It is reported that in the latter part of 1934 Japan purchased unusually large quantities of asbestos from Canada, the U. S. S. R., South Africa, and Cyprus.[3]

Code developments.—A code of fair competition for the asbestos-products industry became effective in November 1933, and the code authority authorized therein was elected in 1934. The insulation contractors' code was also signed during 1934. Five subcode authorities, representing respectively the paper, cement-products, magnesia, textile, and brake-lining divisions of the industry, were organized, and their personnel was elected.

REVIEW BY STATES

Arizona.—No commercial mining of asbestos was done in Arizona in 1934, but a small quantity of chrysotile was taken out during assessment work; sales recorded by the Bureau of Mines for this State represent withdrawals from stock.

Maryland.—The Powhatan Mining Corporation produced two grades of amphibole in 1934—extra-long and very short fiber—from the Todd mine (formerly the Jenkins) near Pylesville.

Montana.—Peter F. Karst produced a small quantity of short-fibered amphibole in 1934 during assessment work at his property 20 miles southwest of Gallatin Gateway. The Montbestos Co. (formerly United Asbestos Products Corporation) operated its property in southeastern Madison County but made no sales in 1934. According to report, samples of chrysotile submitted for inspection were satisfactory and an enlarged output in 1935 is anticipated. The company undertook additional underground development during 1934 and installed new machinery for finishing and grading the material.

Vermont.—The Vermont Asbestos Corporation of America produced six grades of milled chrysotile asbestos from its property near Hyde Park, Lamoille County. This was the only commercial production of chrysotile in the United States in 1934. The other chrysotile reported to the Bureau of Mines as sold was shipped from stock. Vermont fiber is well adapted to the manufacture of molded brake linings, one of its important uses. It is employed also in asbestos-cement shingles, asbestos paper, pipe covering, paint, and boiler covering. The longest grade marketed is shingle stock, testing 0–2–10–4.

Washington.—Asbestos-Talc Products of Washington, Inc., Burlington, produced a small quantity of amphibole in 1934.

DOMESTIC AND FOREIGN DEPOSITS

Domestic and foreign deposits of asbestos are described in a recent Bureau of Mines report.[4]

[3] Asbestos, vol. 16, February 1935, p. 22.

[4] Bowles, Oliver, Asbestos—Domestic and Foreign Deposits: Inf. Circ. 6790, Bureau of Mines, 1934, 24 pp.

FOREIGN TRADE[5]

Imports.—The following table shows for 1933 and 1934 the imports of unmanufactured asbestos into the United States. Of the total in 1934 designated as "Crude" about 50 percent originated in Africa, 31 percent in Canada, and 18 percent in the U. S. S. R.

Asbestos (unmanufactured) imported into the United States, 1933–34, by countries and classes[1]

Country	Crude (including blue fiber)		Mill fiber		Stucco and refuse		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1933								
Africa, British:								
Union of South Africa	233	$20,173					233	$20,173
Other British	2,091	214,384					2,091	214,384
Canada	804	167,795	48,112	$2,170,157	63,999	$854,647	112,915	3,192,599
Finland					37	1,404	37	1,404
Germany	6	669			36	1,064	42	1,733
Italy	18	8,929			939	7,764	957	16,693
Malta, Gozo, Cyprus					2,274	37,395	2,274	37,395
U. S. S. R. (Russia)			176	17,339	795	39,439	971	56,778
United Kingdom	(2)	587			11	339	11	926
Venezuela					11	398	11	398
	3,152	412,537	48,288	2,187,496	68,102	942,450	119,542	3,542,483
1934								
Africa, British:								
Union of South Africa	595	62,667					595	62,667
Other British	1,199	135,812					1,199	135,812
Canada	1,093	218,649	41,960	1,807,512	70,007	1,000,402	113,060	3,026,563
Egypt					100	1,417	100	1,417
Finland					38	1,920	38	1,920
Italy	16	9,775			246	1,774	262	11,549
Malta, Gozo, Cyprus					2,463	43,611	2,463	43,611
U. S. S. R. (Russia)	657	26,434			1,938	63,005	2,595	89,439
United Kingdom	22	5,016					22	5,016
	3,582	458,353	41,960	1,807,512	74,792	1,112,129	120,334	3,377,994

[1] Data on total imports in 1934 and 1933 may not be strictly comparable due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.
[2] Less than 1 ton.

Crude asbestos is not classified uniformly. The foregoing table of imports shows that Canadian crude is valued in 1934 at about $200 a ton, African crude at $111, Russian at $40, and the small quantity from Italy at more than $600. Although some variations in prices are to be expected because of varying quality and the proportions of Crude No. 1 and Crude No. 2 involved, it is evident that material averaging as low as $40 a ton is not crude in the sense in which the term is generally employed in the United States and Canada. An effort is being made to standardize the classification of imported asbestos and to induce all exporting countries to report shipments according to the classification.[6] It is proposed that asbestos be classified into

[5] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.
[6] Asbestos, Better Statistics on Asbestos: March 1935, pp. 16–18.

four grades, defined as follows: "Crudes", the two grades of unopened asbestos used for spinning; "Spinning fiber", mill fiber testing 0–8–6–2 or over; "Nonspinning fiber", below 0–8–6–2 and including 0–0–5–11 material; and "Shorts", below 0–0–5–11. Adherence to such a classification would be a statistical convenience and would clarify discussion.

Canada is shown in the table as the only source of mill fiber in 1934, whereas some of the fiber from other countries classified as crude probably should be designated as mill fiber.

Canada continues to be the principal source of short fiber for the United States; about 93 percent of the total imported in 1934 originated there, about 3 percent in Cyprus, nearly 3 percent in the U. S. S. R., and most of the remainder in Italy.

Exports.—The following table shows exports of asbestos products in 1933 and 1934. The considerable increase in exports of molded brake linings, while exports of woven linings remained practically unchanged, indicates the growing use of the former type. This tendency is important to producers of raw asbestos because it involves larger consumption of the better grades of nonspinning fiber at the expense of the spinning grades. Exports of asbestos roofing declined sharply, but most other products showed large gains.

Manufactured asbestos products exported from the United States, 1933–34, by kinds

Product	1933		1934	
	Quantity	Value	Quantity	Value
Brake lining:				
Molded and semimolded	(1)	$468,549	(1)	$607,193
Not molded ... linear feet	1,651,425	256,018	1,641,333	255,018
Paper, millboard, and roll board ... short tons	439	62,851	602	96,154
Pipe covering and cement ... do	910	93,936	1,389	126,929
Textiles, yarn, and packing ... do	518	510,186	619	593,886
Magnesia and manufactures ... do	695	91,836	1,277	241,410
Asbestos roofing ... squares	85,532	150,283	26,457	75,254
Other manufactures ... short tons	839	109,481	794	146,670

1 Quantity not recorded.

WORLD PRODUCTION

The chief asbestos-producing areas of the world are Quebec, Canada; Southern Rhodesia; the Union of South Africa; the U. S. S. R.; and Cyprus. Relatively small quantities are produced in Italy, Australia, and several other countries. The following table shows world production by countries from 1930 to 1934, insofar as figures are available.

World production of asbestos, 1930–34, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country [1]	1930	1931	1932	1933	1934
Africa:					
Portuguese East Africa	[2] 16		(3)	(3)	(3)
Southern Rhodesia	34, 260	21, 810	14, 302	27, 381	29, 224
Swaziland			5		(3)
Union of South Africa	17, 491	14, 221	10, 951	14, 412	15, 960
Argentina			7		(3)
Australia:					
New South Wales		8		(3)	(3)
South Australia		6	20	13	(3)
Western Australia	144	116	112	270	(3)
Canada [4]	219, 641	149, 047	111, 562	143, 667	141, 502
China	315	264	(3)	(3)	(3)
Chosen				12	(3)
Cyprus [2]	5, 487	3, 628	1, 626	4, 640	7, 451
Finland	1, 188	581	756	1, 340	(3)
France	503	500	(3)	(3)	(3)
Greece	2	10	9	(3)	(3)
India, British	34	6	91		(3)
Italy	851	632	1, 284	3, 267	(3)
Japan [5]	1, 000	1, 000	1, 000	1, 000	1, 000
Turkey	(3)	4	58	120	(3)
U. S. S. R. (Russia)	54, 083	64, 674	60, 000	74, 000	(3)
United States (sold or used by producers)	3, 848	2, 928	3, 229	4, 305	4, 615

[1] In addition to countries listed Madagascar reported production of 350 kilograms of asbestos in 1933.
[2] Exports.
[3] Data not available.
[4] Exclusive of sand and gravel, production of which is reported as follows: 1930, 36,949 tons; 1931, 6,540 tons; 1932, 3,151 tons; 1933, 5,850 tons; 1934, 4,238 tons.
[5] Approximate production.

CANADA

Production of asbestos in the Province of Quebec declined 1.5 percent in quantity and more than 5 percent in value in 1934 compared with 1933. The decrease was in the long-fiber and medium-mill-fiber grades.

According to the Dominion bureau of statistics, 11 asbestos-products plants—2 less than in 1932—operated in Canada in 1933. The value of asbestos products manufactured in Canada was $757,626 in 1933, compared with $1,067,801 in 1932 and $1,308,183 in 1931.

The following table shows the production of asbestos in 1934 as published in the preliminary report of the Quebec bureau of mines.

Production of asbestos in the Province of Quebec for 1934

Designation of grade	Shipments and sales		Average value per ton
	Short tons	Value	
Crudes	1, 663	$409, 853	$246. 45
Fibers	77, 465	3, 456, 399	44. 62
Shorts	76, 852	1, 070, 074	13. 92
Total	155, 980	4, 936, 326	31. 65
Sand, gravel, and stone (waste rock only)	4, 672	3, 480	. 74
Total	160, 652	4, 939, 806	

Quantity of rock mined in 1934: 2,320,750 tons.
Quantity of rock milled in 1934: 1,935,129 tons.

AFRICA

Rhodesia.—Production of asbestos in Southern Rhodesia increased nearly 7 percent in 1934 compared with 1933, but its value decreased nearly 28 percent. The drop in average value from £184 a ton in 1933 to £125 in 1934 indicates that larger quantities of the lower grades of asbestos were produced. Plant capacity was increased recently to provide for an enlarged output from the Shabani and Birthday properties. New developments included a 960-foot inclined shaft, a mill for treating rock with an arrangement for disposing of waste, and a grading mill. The following table shows Rhodesian production from 1925 to 1934.

Asbestos produced in Rhodesia, 1925–34

Year	Short tons	Value	Year	Short tons	Value
1925–29 (average)	36,693	£888,877	1932	15,766	£197,092
1930	37,765	1,070,847	1933	30,182	555,993
1931	24,042	386,494	1934	32,214	402,745

Union of South Africa.—Production of asbestos in the Union of South Africa increased 11 percent in quantity and 3 percent in value in 1934 compared with 1933. The Cape Asbestos Co., at its annual meeting, announced a net profit of £21,877 for the fiscal year. A 5-percent dividend on preferred shares was paid, and a 6-percent dividend on ordinary shares was recommended. The following table shows the output in the Union of South Africa from 1925 to 1934.

Asbestos produced in the Union of South Africa, 1925–34, by sources

Year	Short tons				Total value
	Transvaal	Cape Province	Natal	Total	
1925–29 (average)	16,201	4,494	5	20,700	£321,765
1930	13,800	5,481		19,281	340,795
1931	12,025	3,651		15,676	246,583
1932	9,106	2,964		12,070	116,401
1933	12,662	3,225		15,887	197,120
1934	14,783	2,810		17,593	203,033

Production of blue asbestos in Cape Province decreased about 13 percent in quantity and 14 percent in value from 1933 to 1934, but production of chrysotile and amosite, both of which are mined in the Transvaal, showed substantial gains. Blue asbestos also is produced in small quantities in the Transvaal at times. The following table shows production in the Union of South Africa, 1932 to 1934, by varieties.

Asbestos produced in the Union of South Africa, 1932–34, by varieties and sources

	1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value
Amosite (Transvaal)	1,391	£13,906	3,090	£31,099	3,757	£37,104
Chrysotile (Transvaal)	7,715	45,692	9,572	105,715	11,025	114,241
Blue (Transvaal)					1	15
Blue (Cape)	2,964	56,803	3,225	60,306	2,810	51,673
	12,070	116,401	15,887	197,120	17,593	203,033

U. S. S. R. (RUSSIA)

No figures on production of Russian asbestos in 1934 are available, but unofficial reports state that 36,000 metric tons of asbestos (including all grades) were exported. This quantity is said to be the largest on record. Further increases are to be expected.

A new mill for recovering fiber from rock was under construction in the Bajenova district in 1934. According to report, its capacity of 80,000 tons of fiber a year will nearly equal the total capacity of all other plants in the country.[7]

The following table shows available figures for production and exports of Russian asbestos from 1930 to 1934.

Production and exports of Russian asbestos, 1930–34, in metric tons

Year	Production	Exports	Year	Production	Exports
1930	54,083	15,749	1933	[1] 74,000	(2)
1931	64,674	13,239	1934	(2)	[1] 36,000
1932	[1] 60,000	15,915			

1 Unofficial estimate.
2 Data not available.

CYPRUS

Extensive deposits of short-fibered chrysotile on Mount Troodos are worked during the dry season—about 6 months a year. The 12 mills on the island for separating fiber from rock have an annual capacity of 25,000 tons of asbestos. The entire output is exported. Exports have recovered greatly from the low level of 1932. A small quantity of spinning-grade fiber has been mined recently. It is reported that 5 tons of such fiber was shipped to the United States in 1934,[8] but no separate entry of its receipt appears in the import figures of the United States Bureau of Foreign and Domestic Commerce for 1934. The following table shows exports of asbestos from Cyprus from 1930 to 1934.

Asbestos exported from Cyprus, 1930–34

Year	Long tons	Value	Year	Long tons	Value
1930	5,400	£116,092	1933	[1] 4,590	[1] £44,088
1931	3,571	66,381	1934	[1] 7,334	[1] 73,562
1932	1,600	27,214			

1 Reported by Cyprus & General Asbestos Co., Ltd.

7 U. S. Bureau of Foreign and Domestic Commerce, Foreign Trade Notes—Minerals and Metals: Vol. 3, July 31, 1934, p. 10.
8 Private communication.

BARITE AND BARIUM PRODUCTS

By B. H. Stoddard

SUMMARY OUTLINE

Conditions in the domestic barite-mining industry in 1934 were encouraging to the producers. Prices were too low to justify extensive expansion of mining operations, but total stocks at railroad shipping points were reduced materially owing to a general improvement in demand. In Missouri, which produced 57 percent of the total domestic output of crude barite in 1934, reduction in stocks apparently did not result in the reopening of any former operations, prices did not rise, and no new mining developments were reported. Many of the so-called "tiff diggers" were idle because there was no need for an increase in production. In California and Nevada, however, new properties were developed and commercial shipments made therefrom. Increased purchases of domestic material by importers and a further reduction in imports of crude barite into the United States in 1934 also affected the domestic situation.

Figure 120 shows recent trends in sales of crude barite from domestic mines, imports, consumption, and prices in the United States.

There were substantial gains in total sales of barium products. Not all of the individual products, however, reported progress, as sales of barium sulphate declined appreciably.

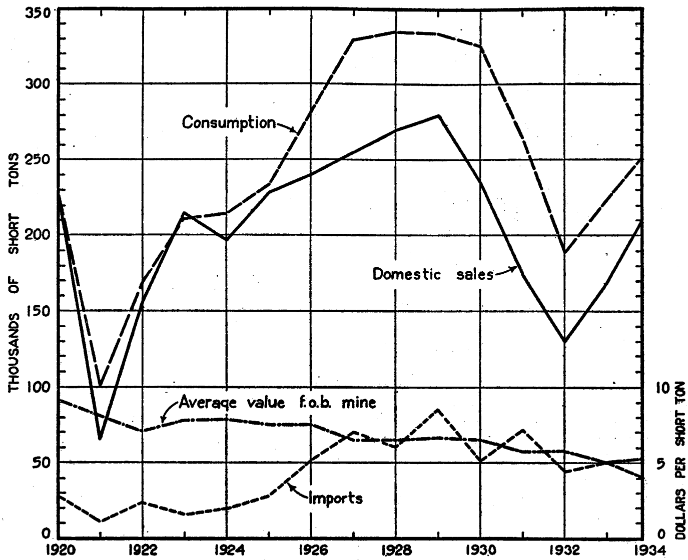

FIGURE 120.—Trends in sales, imports, consumption, and prices of crude barite, 1920–34.

Salient statistics covering barite and leading barium products are summarized in the following table:

Salient statistics on barite and barium products in the United States, 1926–34

	1926–30 (average)	1931	1932	1933	1934
Crude barite:					
Produced ... short tons	244,926	210,930	133,572	146,402	178,361
Sold or used by producers:					
Short tons	254,777	174,520	129,854	167,880	209,850
Value: [1]					
Total	$1,717,594	$994,655	$745,955	$852,611	$1,109,378
Average	$6.74	$5.70	$5.74	$5.08	$5.29
Imports for consumption:					
Short tons	64,179	73,080	45,758	49,958	40,031
Value: [2]					
Total	$220,612	$329,114	$177,954	$216,955	$174,937
Average	$3.44	$4.50	$3.89	$4.34	$4.37
Apparent new supply [3] ... short tons	318,956	247,600	175,612	217,838	249,881
Domestic ... percent	79.9	70.5	73.9	77.1	84.0
Reported consumption (total) short tons	321,108	265,270	189,409	223,047	250,476
Barium products:					
Sold or used by producers:					
Short tons	269,410	228,326	177,836	215,525	228,796
Value	$20,564,285	$16,365,522	$12,191,374	$14,170,890	$15,173,923
Imports for consumption:					
Short tons	24,901	12,912	10,561	12,236	9,459
Value	$1,145,908	$624,272	$385,662	$464,812	$475,262
Exports of lithopone:					
Short tons	3,120	3,821	3,212	1,186	2,401
Value	$320,769	$341,257	$270,195	$107,923	$199,508

[1] F. o. b. mine shipping point.
[2] Declared value f. o. b. foreign market.
[3] Barite sold or used by producers plus imports.

CRUDE BARITE

Production and sales.—In 1934 crude barite was mined in the United States in California, Georgia, Missouri, Nevada, South Carolina, Tennessee, and Virginia. Total mine production was 178,361 short tons, or 22 percent more than in 1933. Total sales of crude barite amounted to 209,850 tons valued at $1,109,378. These figures exceed those for 1933 by 25 percent in quantity and 30 percent in value. The total domestic output was contributed by approximately 95 producers distributed as follows: Missouri, 83; California, 4; Georgia, 3; Nevada, 2; and South Carolina, Tennessee, and Virginia, 1 each. Missouri produced 57 percent of the total crude barite shipped or used in the United States in 1934 compared with 67 percent in 1933; 79 percent of the output in Missouri in 1934 was mined in Washington County.

MARKETS AND PRICES

Market areas.—According to reports of consumers, crude barite was shipped for consumption in California, Colorado, Delaware, Georgia, Illinois, Kansas, Maryland, Missouri, New Jersey, New York, Ohio, Pennsylvania, South Carolina, Texas, and West Virginia. California's output was utilized entirely within the State. Georgia shipped crude barite to consumers within the State and to plants in Illinois, Maryland, New Jersey, Pennsylvania, and West Virginia. Shipments from Missouri were consumed in Colorado, Illinois, Kansas, Missouri, New Jersey, New York, Ohio, and Pennsylvania. Nevada shipped its total production to California. South Carolina consumed its output within the State. Tennessee shipped to Delaware, Maryland, Ohio, and West Virginia, and the one producer in Virginia shipped to its plant in West Virginia.

Prices.—Market quotations for crude barite [1] showed no changes during the year. Crude from California was quoted at $6 a short ton; Georgia crude at $7 a long ton; and Missouri crude at $5 a short ton. Water-ground, floated, and bleached Missouri barite remained nominal at $23 a short ton.

Average prices per ton for crude barite sold by producers, however, showed wide variations compared with 1933, especially in States having only one or two producers. Thus, in Nevada the average price per ton in 1934 was less than half that in 1933. In California the average price per short ton in 1934 was $5.72 compared with $5.87 in 1933. In Georgia the price in 1934 was $6.41 a short ton and in 1933 $6.55. In Missouri, however, the average price per ton in 1934 was $4.90 compared with $4.54 in 1933. Average prices in other States cannot be compared because there was only one producer in each State.

[1] Metal and Mineral Markets, New York (weekly).

Range of quotations on barite and barium products, 1932–34 [1]

	1932	1933	1934
Crude barite, f. o. b. mines:			
California ... short ton	$6.00 -$7.00	$5.50 -$7.00	$6.00
Georgia ... long ton	6.00 - 6.50	6.00 - 7.00	7.00
Missouri [2] ... short ton	5.00 - 6.00	4.50 - 5.00	5.00
Ground barite, barrel, St. Louis ... do	23.00	23.00	23.00
Ground witherite, works [3] ... do	40.00 -42.00	40.00	$42.00 -45.00
Lithopone, January–November, 400-pound barrel, l. c. l ... pound	.04¾- .05	.04¾- .05	.04¾- .05
December, domestic, ordinary, delivered, bags ... pound	...	...	.04½- .04¾
Barrels ... do	...	...	.04¾- .05
High strength, bags ... do	...	...	.06 - .06¼
High strength, barrels ... do	...	...	.06¼- .06½
Titanated, bags ... do	...	...	.06 - .06¼
Titanated, barrels ... do	...	...	.06¼- .06½
Barium carbonate, 200-pound bags ... short ton	47.00 -57.00	56.50 -61.00	56.50 -61.00
Barium chlorate, 112-pound kegs, New York ... pound	.13¾- .15	.13¾- .16	.14 - .16
Barium chloride, 600-pound barrel, works ... short ton	63.00 -69.00	61.50 -74.00	72.00 -74.00
Barium dioxide (binoxide or peroxide), 88 percent, 690-pound drums ... pound	.11 - .13	.11 - .13	.11 - .13
Barium hydrate, 500-pound barrel ... do	.04¾- .05½	.04¼- .05	.04¾- .06
Barium nitrate, 700-pound casks ... do	.07 - .08	.07¼	.07¼- .08¼
Barium sulphate, precipitated (blanc fixe), 400-pound barrel ... short ton	60.00 -80.00	[4] 42.50 -75.00	[4] 42.50 -75.00

[1] Chemical Industries (formerly Chemical Markets), New York (monthly); Metal and Mineral Markets, New York (weekly); Oil, Paint, and Drug Reporter, New York (weekly).
[2] 95 percent barium sulphate, less than 1 percent iron.
[3] 90 percent through 300-mesh.
[4] Lowest price for pulp grade.

Consumption by uses.—In 1934 consumption of domestic and foreign crude barite in the United States by 30 plants, as reported by con-

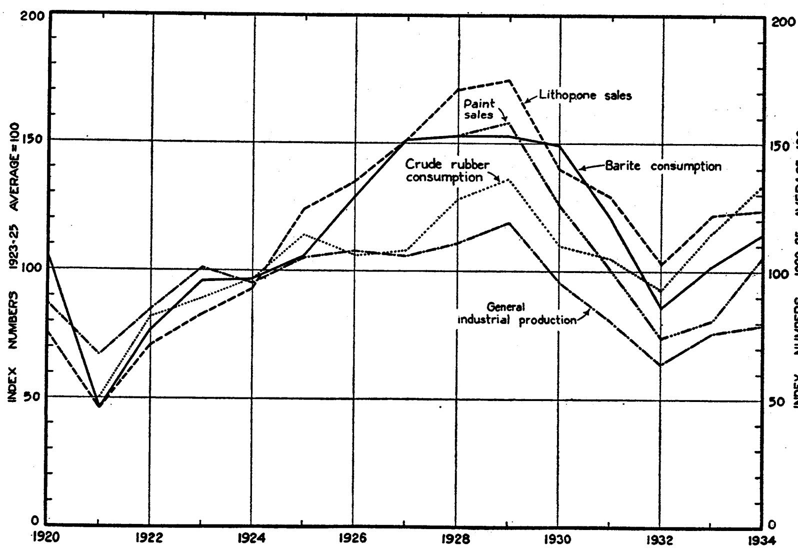

FIGURE 121.—Crude barite consumption and domestic lithopone sales compared with general industrial production, crude rubber consumption, and value of total paint sales, 1920–34.

sumers, was 250,476 short tons, an increase over 1933 of 27,429 tons (12 percent). Ground barite accounted for 61,123 tons; lithopone, 140,734 tons; and barium chemicals, 48,619 tons.

Figure 121 shows the trend for crude barite consumption compared with lithopone sales, value of total paint sales, crude rubber consumption, and general industrial production.

Crude barite (both domestic and imported), used in the manufacture of barium products in the United States, 1930–34, in short tons

Year	In manufacture of—			Total	Year	In manufacture of—			Total
	Ground barite	Lithopone	Barium chemicals			Ground barite	Lithopone	Barium chemicals	
1930	69,426	178,944	76,825	325,195	1933	38,026	131,761	53,260	223,047
1931	35,393	157,181	72,696	265,270	1934	61,123	140,734	48,619	250,476
1932	36,402	120,378	32,629	189,409					

Domestic and imported crude barite used in the manufacture of barium products in the United States in 1934, by States, in short tons

State	Product manufactured	Plants [1]	Barite used
Missouri	Ground barite and chemicals	5	54,900
Illinois	Ground barite, lithopone, and chemicals	6	45,725
New Jersey	Lithopone and chemicals	3	35,073
California	Ground barite, lithopone, and chemicals	4	27,053
Delaware and Maryland	Lithopone	2	87,725
Pennsylvania	Lithopone and chemicals	2	
West Virginia	Chemicals	2	
Kansas	Lithopone	1	
Texas	Ground barite	1	
New York	Ground barite and chemicals	2	
South Carolina	Ground barite	1	
Georgia	do	1	
		30	250,476

[1] A plant producing more than one product is counted but once in arriving at State totals.

REVIEW BY STATES

California.—With virtually the same producers as in 1933 California's crude-barite industry made gains in 1934 of over 100 percent in mine production and shipments. Total mine production was 21,793 short tons, and shipments were reported as 21,783 short tons valued at $124,664. Stocks on hand at mines or plants at the end of 1934 were approximately 5,550 tons. Major mining operations were conducted by the National Pigments Co. (St. Louis, Mo.), at its El Portal mine in Mariposa County, and by the Synthetic Iron Color Co., Richmond, which operated the Ohio mine in Plumas County. No witherite was mined by the National Pigments Co. in 1934. California's total output of crude barite in 1934 was consumed within the State by three plants in the manufacture of ground barite, lithopone, and barium chemicals. One chemical plant, the Barium Products, Ltd., Modesto, produced the following barium products: Binoxide, carbonate, hydroxide, sulphate, and sulphide. Ground barite was produced at the plants of the Chemical & Pigment Co., Oakland, and the National Pigments Co., El Portal, and lithopone was manufactured by one plant—the Chemical & Pigment Co., Oakland. The Commercial Minerals Co. of San Francisco also manufactured ground barite from imported material.

New development was reported on a Government claim in Tulare County near Springville. The property was located July 1, 1934, and crude ore was shipped to a consumer in Los Angeles.

Georgia.—In 1934 barite mining activities in Georgia were concentrated in Bartow County, as usual. Total mine production and shipments increased over 20 percent compared with 1933. Mining operations were conducted by the Georgia Barium & Ochre Co., the New Riverside Ochre Co., and the Paga Mining Co., all of Cartersville. Thompson, Weinman & Co., Cartersville, the only consumer of crude barite in the State, used part of the total output in the manufacture of ground barite.

Missouri.—Barite occurs in Missouri at shallow depth in beds of residual clay and, except for periods of great activity, is dug largely by hand. In addition to clay, common impurities are iron oxide stains and masses of galena. After the material has remained in the sun and rain, however, much of the clay becomes detached and falls off. Then hand cobbing, picking, and sorting render it suitable for shipment to mills.

In 1934 mining operations in some areas in Missouri were barely active owing in part to the extremely low prices that prevailed. On the other hand, several of the more regular operators seemed to have been able to profit from a general, although slight, improvement in demand.

Total mine production in Missouri in 1934 was 87,087 short tons. Shipments totaled 118,836 tons valued at $581,889, and stocks at mines or plants were reported to be about 59,000 tons. Mine production in Missouri has advanced less than 2 percent in the last 2 years, following a decrease of 25 percent in 1932, while shipments have increased more rapidly—31 percent in quantity and 10 percent in value in 1933 and 6 percent in quantity and 14 percent in value in 1934. Stocks of crude ore at mines or plants increased slightly in 1932 but have declined steadily since—16 percent in 1933 and 8 percent in 1934. A few of the smaller properties in Missouri changed ownership in 1934.

Nevada.—Two operators in Nevada in 1934 contributed the total shipments of crude barite. The Chemical & Pigment Co., Inc., Oakland, a new operator in this field, in July 1934 leased the Barium King mine in Lander County near Battle Mountain, which hitherto had been undeveloped. Shipments were made to the company processing plant in Oakland, Calif. Another new operator was the Industrial Minerals & Chemical Co., Berkeley, Calif., which in June 1934 took over two properties, the White Rock mine in Eureka County near Dunphy, and the Carlin mine in Elko County; the latter formerly was operated by the American Development Co., Ltd. Development work only was conducted at the White Rock mine, but shipments were made from the Carlin mine to the plant of the Industrial Minerals & Chemical Co., Berkeley, Calif.

South Carolina.—In 1934 the mines at Kings Creek, Cherokee County, operated by the Clinchfield Sand & Feldspar Corporation, were the only sources of production in the State. The material was ground at the corporation plant before being sold.

Tennessee.—The L. A. Wood Co., Sweetwater, incorporated in March 1934, was the only reported producer of crude barite in Tennessee in 1934. Production was obtained from properties in McMinn and Monroe Counties near Calhoun and Sweetwater and sold crude to consumers in Delaware, Maryland, Ohio, and West Virginia.

Virginia.—Total production of crude barite in Virginia in 1934 was made by the Barium Mining Corporation, South Charleston, W. Va., at its property in Campbell County, Va., near Gretna. The total output was consumed at the corporation plant in West Virginia in the manufacture of barium chemicals.

FOREIGN TRADE [2]

Imports.—Total imports of crude barite into the United States have dropped gradually from 73,080 short tons valued at $329,114 in 1931 to 40,031 tons valued at $174,937 in 1934. This decline is due partly to the reduction in imports from Germany, which have declined steadily from 41,117 tons valued at $136,677 in 1931 to 16,643 tons valued at $63,845 in 1934. In 1934 imports of crude barite from the Netherlands increased 58 percent in quantity and 52 percent in value compared with 1933. Russian imports into the United States have dropped steadily from 13,399 tons valued at $83,084 in 1931 to 2 tons valued at $20 in 1934. Shipments of crude barite from Spain to the United States were 6,720 short tons valued at $13,882 in 1934 compared with 1,187 tons valued at $2,650 in 1933. The average value per ton of Spanish material ($2.07) is far lower than the average for any of the other countries. Imports from Italy, which had risen from 11 short tons valued at $173 in 1931 to 6,493 tons valued at $43,292 in 1933, declined in 1934 to 56 tons valued at $352.

Exports.—Exports of crude barite from the United States are not separately recorded.

Crude barite imported into the United States, 1933–34, by countries

Country	1933		1934	
	Short tons	Value	Short tons	Value
Belgium			397	$2,847
France			114	876
Germany	31,383	$105,558	16,643	63,845
Italy	6,493	43,292	56	352
Netherlands	9,913	59,212	15,651	89,850
Spain	1,187	2,650	6,720	13,882
United Kingdom			448	3,265
U.S.S.R. (Russia)	982	6,243	2	20
	49,958	216,955	40,031	174,937

WORLD PRODUCTION

The following table shows the output of barite by various countries from 1930 to 1934, as far as statistics are available.

[2] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

World production of barite, 1930–34, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1930	1931	1932	1933	1934
Algeria	2,403	944	890	10	(1)
Australia:					
New South Wales	176	124	309	323	(1)
South Australia	1,560	1,468	1,728	1,800	(1)
Tasmania	----	----	----	5	(1)
Austria	496	87	275	1,030	(1)
Canada	60	15	----	18	----
Chosen	6,096	5,460	6,569	4,969	(1)
France	32,650	11,300	10,400	(1)	(1)
Germany:					
Bavaria	17,778	7,835	5,853	(1)	(1)
Prussia [2]	217,925	160,482	102,167	143,465	(1)
Saxony	480	2,534	2,446	130	(1)
Great Britain	59,647	46,312	57,548	67,689	(1)
India (British)	6,906	5,745	3,004	5,742	(1)
Irish Free State	1,524	864	----	----	(1)
Italy	23,420	24,326	21,861	23,444	(1)
Portugal	----	80	----	2	1
Southern Rhodesia	249	----	----	(1)	(1)
Spain	5,552	8,539	8,934	4,605	(1)
United States [3]	215,460	191,351	121,174	132,813	161,806

[1] Data not available.
[2] Official figures which, it is reported, cover only output of mines included under the mining law.
[3] Figures for 1930–34, inclusive, represent mine production. Those for prior years represent sales and shipments.

BARIUM PRODUCTS

Sales.—The increased consumption of crude barite in 1934 was largely accounted for by a sharp recovery in sales of ground barite, lithopone, and barium chemicals. Total sales of barium products in the United States were 228,796 short tons valued at $15,173,923 in 1934 compared with 215,525 tons valued at $14,170,890 in 1933. Sales of barium binoxide in 1934 increased more than 6 times in quantity and 4 times in value over 1933. Ground barite increased 54 percent in quantity and 47 percent in value; barium carbonate (precipitated), 24 percent in quantity and 35 percent in value; barium chloride, 11 percent in quantity and 17 percent in value; and lithopone, 3 percent in quantity and 4 percent in value. Barium sulphate (precipitated) was the only important chemical with decreased sales in 1934—41 percent in quantity and 9 percent in value.

Barium products sold or used by producers in the United States, 1930–34 [1]

Year	Ground barite			Lithopone			Blanc fixe (precipitated barium sulphate)		
	Plants	Short tons	Value	Plants	Short tons	Value	Plants	Short tons	Value
1930	6	55,284	$1,140,305	12	164,065	$15,897,683	5	(2)	(2)
1931	9	32,297	656,769	11	151,850	12,999,590	7	31,151	$1,827,713
1932	12	33,842	563,902	11	121,667	10,176,856	7	14,454	933,068
1933	13	34,601	683,432	11	140,831	11,751,500	9	30,744	1,197,131
1934	13	53,326	1,006,905	11	145,565	12,235,624	6	18,115	1,084,733

[1] To avoid duplication, the barium chemicals reported here do not include the output of firms that make these chemicals from such products as barium chemicals and imported barite and witherite purchased in the open market; the total for barium chemicals is therefore not shown here.
[2] Included under "Other barium chemicals."

Barium products sold or used by producers in the United States, 1930–34—Contd.

Year	Artificial barium carbonate (chemically precipitated)			Barium chloride			Other barium chemicals [3]		
	Plants	Short tons	Value	Plants	Short tons	Value	Plants	Short tons	Value
1930	6	5,224	$260,284	(2)	(2)	(2)	7	26,139	$1,495,243
1931	6	5,687	253,189	(2)	(2)	(2)	7	7,341	628,261
1932	6	3,295	149,869	3	3,955	$240,843	5	623	126,836
1933	4	3,810	181,857	(2)	(2)	(2)	9	5,539	356,970
1934	4	4,706	245,315	(2)	(2)	(2)	7	7,084	601,346

[2] Included under "Other barium chemicals."
[3] Figures cover chemicals as follows: 1930: Binoxide, chloride, hydroxide, monoxide, oxide crystals, sulphate, and sulphide; 1931: Binoxide, chloride, oxide, and sulphide; 1932: Binoxide, hydroxide, oxide, and sulphide: 1933 and 1934: Binoxide, chloride, hydroxide, and sulphide.

Lithopone sold or used by producers, 1932–34, by consuming industries

Industry	1932		1933		1934	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints, enamels, and lacquers	93,465	76.8	106,995	76.0	114,472	78.6
Floor coverings and textiles	17,601	14.5	18,472	13.1	14,811	10.2
Rubber	3,955	3.2	5,078	3.6	4,596	3.2
Other	6,646	5.5	10,286	7.3	11,686	8.0
	121,667	100.0	140,831	100.0	145,565	100.0

Imports and exports.—Total imports of barium products into the United States in 1934 were 9,459 short tons valued at $475,262 compared with 12,236 tons valued at $464,812 in 1933. The quantity and value of the various products imported are shown in the following table. Of the products listed imports of barium sulphate, chloride, nitrate, and hydroxide increased over 1933, while imports of ground barite, lithopone, barium binoxide, witherite, barium oxide, and barium compounds (n. e. s.) declined.

Barium compounds imported for consumption in the United States, 1930–34

[Value at port of shipment]

Year	Ground barite		Lithopone		Barium binoxide		Blanc fixe (precipitated barium sulphate)		Artificial barium carbonate (chemically precipitated)	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	2,331	$26,905	7,018	$595,597	(1)	$28	2,994	$133,260	2,662	$52,427
1931	1,851	22,415	5,674	428,523	(2)	11	930	38,083	1,110	20,839
1932	1,594	16,757	4,724	271,678	(3)	27	656	24,100	303	5,630
1933	2,632	30,492	5,596	313,341	1	82	245	12,093	49	1,632
1934	1,863	16,916	3,927	219,752	(4)	58	459	26,156		

[1] 222 pounds. [2] 122 pounds. [3] 328 pounds. [4] 370 pounds.

Barium compounds imported for consumption in the United States, 1930–34—Con.

Year	Witherite, crude, unground[5]		Barium chloride		Barium nitrate		Barium hydroxide		Barium oxide		Barium compounds (n. e. s.)	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	2,562	$52,282	7	$372	407	$31,985	220	$12,235	(6)	(6)	(7)	(7)
1931	2,352	39,964	6	201	423	29,796	345	25,570	221	$18,870	(7)	(7)
1932	2,680	34,336	39	1,208	330	21,421	235	10,494	(8)	11	(7)	(7)
1933	2,949	47,324	6	526	359	31,140	281	15,542	110	9,416	8	$3,224
1934	2,358	143,808	107	4,808	454	44,884	287	17,548	(9)	66	4	1,266

[5] Recorded as "Witherite" prior to June 18, 1930.
[6] Not separately recorded prior to 1931.
[7] Not separately recorded prior to 1933.
[8] 22 pounds
[9] 132 pounds.

Lithopone exported from the United States, 1930–34

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1930	3,665	$380,047	$103.70	1933	1,186	$107,923	$91.00
1931	3,821	341,257	89.31	1934	2,401	199,508	83.09
1932	3,212	270,195	84.12				

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POTASH

By J. H. Hedges

SUMMARY OUTLINE

The effect on world trade in potash of active exploitation of potash deposits in Spain, the U. S. S. R. (Russia), and the United States began to be felt in the principal world markets in 1933. These deposits first were explored seriously when shipments from the great mines of Germany were interrupted during the war. During 1934 increasing pressure of unemployed capacity to produce surplus potash sharpened competition between the principal suppliers and engendered a trade war that lowered quotations for the various grades of potash fertilizer salts to hitherto unknown levels. Germany and France defended their traditional domination of the potash trade. Spain actively pushed the sale of her growing exportable surplus derived from mines favorably situated with respect to transportation. American producers sought to retain their position in the home market. The U. S. S. R. traded increasing quantities of the Solikamsk output, at any price obtainable, for foreign credits or foreign goods. Moderately increased world consumption failed to absorb added offerings. Ensuing demoralization of the market characterized the year's business.

Although the story of potash and the far-flung industry built around it often has been told, extraordinary developments recorded in 1934 justify a brief review as a background for discussion of the present state of the industry. Potash mining and refining, from small beginnings at Stassfurt, Germany, about 1860, has become a major industry of world-wide importance. From the beginning development outstripped demand. New mines and plants were constructed faster than their product could be absorbed by expanding markets. Efforts to control and regulate output and price were only intermittently successful even before the World War, when potash production was a German monopoly. War-time and post-war developments in other countries vastly extended world reserves and induced destructive competition culminating in 1934 in a struggle that long will be remembered by those engaged in the potash trade.

The following sketch touches only the highlights. Complete details have been included in earlier volumes of Mineral Resources of the United States (1887, 1910, and succeeding years) and many other publications of the Geological Survey, the Bureau of Mines, and the Bureau of Soils—the three Government agencies closely identified with the successful search for domestic sources of potash capable of supplying American requirements.

HISTORY OF POTASH INDUSTRY

The discovery about 1858, credited to Justus von Liebig, that potash salts present in soil constitute essential plant food which is exhausted by continued cultivation and that soil fertility can be restored by application of potash fertilizers, opened an enormous potential market for suitable potash material. The disclosure, at about the same time, in a shaft at Stassfurt sunk for mining rock salt, of large deposits of soluble potash salts provided an abundant source of cheap raw material to test the value of Von Liebig's discoveries.

Earlier uses for potassium salts, principally in the manufacture of gunpowder, glass, soft soap, and chemical and pharmaceutical preparations, consumed relatively small amounts. Before 1860 the chief sources of potash were wood ashes; the calcined residue from beet-sugar manufacture; the ashes of other land and marine plants (kelp); and "suint", the sweat of sheep recovered in scouring raw wool, a peculiar substance that yielded chloride, sulphate, and carbonate of potassium on refining. The establishment in 1860, by Dr. Frank, of the first plant to produce potassium chloride from Stassfurt salts, marked the beginning of the mineral-potash industry.

Intelligently conducted educational selling campaigns created a demand for potash fertilizer that brought astounding growth to the infant potash industry. The output of the German mines jumped from 2,293 metric tons of crude salts in 1861 to 115,497 tons in 1864 and by 1882 amounted to over a million tons annually. In 1913, the last pre-war year, nearly 12,000,000 metric tons were mined in Germany and Alsace.

Stassfurt had long been known as a source of common salt. Production of sodium chloride from its saline springs was recorded as far back as 806 A. D. Natural springs later were supplemented by shallow wells from which the brine was pumped, and the industry flourished for a thousand years. According to Georgius Agricola, the first wells were constructed in 1452. This sagacious observer and recorder of the mineral technology of his day, writing in 1546, advanced the theory that the brines of the salt springs and wells derived their salt content from underground salt strata. Nearly 300 years later, when the Stassfurt brine became so dilute it could no longer be worked, the Prussian Government (1839) commenced boring to discover the salt bed from which the brine had been obtained. The top of the rock salt was reached in 1843 at a depth of 770 feet; and the bore, still in salt, was stopped at 1,850 feet. Results were disappointing, since brine from the borehole contained over 20 percent of magnesium and potassium chlorides, and only 5.61 percent of the valued constituent, sodium chloride. However, a shaft was started in 1852 and in 5 years had reached a depth of 1,850 feet. From 770 feet the shaft passed through a bed of potassium and magnesium salts 80 feet thick and at 1,000 feet entered a bed of rock salt in which it was continued 850 feet without reaching the bottom of the bed.

To the rock-salt miner the curiously bitter potassium and magnesium salts were a nuisance, constituting an especially undesirable impurity for all ordinary uses of common salt. The upper beds, containing layers of carnallite mixed with kieserite and rock salt, and other layers mainly of kainite or kieserite mixed with rock salt, were considered of no value, and the salts were called "abraumsalze" or "worthless salts." No attempt was made to utilize these upper beds until 1860, when Dr. Frank built the first plant to produce potassium chloride from abraumsalze. During the next 4 years 17 additional plants were erected in the neighborhood for processing crude salts from the Government mines.

All the mines were Government-owned until 1865, when the Prussian Government authorized the granting of mining concessions to private interests. This resulted in the opening of many new mines and exploration that brought in new fields. Rapid expansion soon led to overdevelopment and overproduction and caused the mine owners, in 1879, to combine under a 5-year agreement to regulate output and price.

The stability brought about by this forerunner of the potash syndicate soon was upset by the opening of additional mines. New agreements were reached and renewed from time to time, each successive renewal or new combination representing an enlarged group of mines and a closer tie-in with the Prussian Government. The first real potash syndicate was formed in 1888. About 1909 dissatisfaction within the syndicate over quota allotments combined with active competition from strong independent interests to bring on a potash war that resulted in passage of the law of May 25, 1910, giving the Imperial German Government absolute control over all potash production. The enactment of this law forced independent producers, brought under Government control, to break long-term contracts favorable to American buyers. The resulting disturbance in the American market caused apprehension and brought consumers to a sudden realization of their complete dependence on a foreign monopoly for supplies of potash essential for fertilizer and other less extensive but equally important uses. Recognition of the need to remedy this dangerous condition led to a systematic search, by Government and private agencies, for commercial sources of potash in the United States, that culminated in the establishment of an industry able to supply our domestic needs at reasonable prices.

Germany, by virtue of a practical monopoly of raw material and aggressive development of both domestic and foreign markets, completely dominated world trade in potash from 1861 until export was limited by embargo during the World War. Although potash mining in Poland dates back to 1862, pre-war output was insignificant. Spanish deposits, discovered in 1912, were undergoing development in pre-war years and did not start production until 1925. Russian deposits were remote and undeveloped. American deposits since developed were undiscovered before the war. War conditions that cut off supplies from Germany in 1915 and raised prices to unheard-of levels stimulated potash development in other countries, notably the United States and Spain. At the conclusion of hostilities Alsace was ceded to France and the Alsatian potash mines came under the control of the French Government. French competition in foreign markets was brisk for a few years but was soon eliminated by a Franco-German agreement concluded in 1924, whereby 32.5 percent of the American market was reserved for France and 67.5 percent for Germany. In 1925 the agreement was extended to include all foreign markets and the proportion changed to 30–70. Thus monopoly was restored for a time.

With the return to the American market of foreign potash at approximately pre-war price levels, the war-fostered domestic industry collapsed, with the exception of one plant working natural brines and a small output of byproduct material. However, from the post-war low of 10,171 short tons of K_2O in 1921 domestic output, chiefly from Searles Lake brines, increased steadily, and the search for other commercial sources continued, resulting eventually in discovery of rich and extensive saline deposits from which production was begun in 1931.

In early post-war years production of Polish mines expanded sharply. Output reached 63,000 metric tons of K_2O in 1929, although comparatively little was offered in foreign markets. However, the development of competitive conditions that might effect market stability was again averted when Poland joined the European cartel in March 1932 and was allotted a quota of 4 percent of the syndicate's foreign sales. Production at the Spanish mines was begun in 1925, but exports did not become an important factor in foreign markets until 1932. In 1933 substantial amounts of Spanish potash were sold abroad, and active competition in the important Dutch market caused sharp price reductions following failure of negotiations between the Franco-German-Polish potash syndicate and Spanish producers. Trial shipments from the U. S. S. R. appearing in various markets, though insignificant in amount, occasioned much speculation regarding Soviet policy in relation to their growing production of potash and further complicated the uncertain outlook at the close of the year.

The beginning of the 1934–35 season found sellers unwilling to commit themselves to a price policy by publication of the usual seasonal schedules. Earlier fears were realized as increased offerings from Spain and substantial shipments from the U. S. S. R. combined with other disturbing factors to demoralize world markets and bring about price concessions in the competition for business that lowered net returns to unprofitable levels. Negotiations resumed in the summer to bring Spain into the European cartel again failed, but negotiators were reported to have made progress in composing their differences and some encouragement was felt. Meanwhile, Spain continued to improve her trading position. The low net price level of 1934 sales is believed to be an entirely unreasonable figure that represents a passing phase and is not likely soon to be repeated.

The outlook for 1935 is more encouraging. Announcement was made in April 1935 that agreement had been reached in principle between the Franco-German Syndicate and the Spanish producers, giving Spain an export quota of 14 to 16 percent in the syndicate. A reputed understanding with the U. S. S. R. whereby she will cooperate with other producers to stabilize prices lacks confirmation but would not be out of line with recent developments. In the United States, new price lists for Atlantic port delivery during the early months of the 1935–36 season, issued by all first-hand dealers, record substantial increases from 1934 lows, and prospects for stable conditions in the trade appear more promising.

American producers are handicapped at home and abroad by the favored position of their chief competitors, who not only enjoy a measure of protection in their home markets but are not restrained from combining to effect market control.

POTASH IN THE UNITED STATES

Early settlers in America obtained potash for the manufacture of soap, gunpowder, and glass by burning wood from the abundant forests and leaching the ashes. For 250 years all domestic requirements were supplied from this source. Statistics of the industry first were gathered and recorded in the census of 1850. The output that year from 569 plants was valued at $1,401,533. The quantity produced was not recorded. Available records indicate a steady increase in quantity and a steady decrease in the value of the product and the number of establishments until 1890. In that year, 75 plants produced 2,553 tons valued at $197,507. Rapid decline in both quantity and value followed, and by 1910 domestic production of potash salts virtually had ceased. Depletion of the forests and importation of cheap salts from the great potash mines of Germany combined to bring about the demise of the domestic industry.

Muriate of potash first was imported from Germany in 1871, when 1,400 tons containing approximately 700 tons K_2O and valued at $61,270 (or $43.76 per ton), was reported. Imports of sulphate and kainite were begun in 1884, when 173 tons of sulphate and 126,167 tons of kainite were entered. The sulphate was valued at $36 and the kainite at $6 per ton. The same year 24,356 tons of muriate valued at $30 per ton and 8,593 tons of other potassium salts (carbonate, bicarbonate, hydroxide, chlorate, chromate, bichromate, iodide, nitrate, and prussiate) valued at $890,368 were imported, bringing total imports of potash material in 1884 to 158,289 tons valued at $2,385,018.

The chief use of muriate at that time was in the manufacture of potassium nitrate for gunpowder. Little, if any, found its way into fertilizer. Manufacture in the United States of so-called "complete" fertilizers by mixing ammoniacal compounds and potash with acidulated phosphate rock probably was begun in a small way about 1879, when the first imports of material listed as crude potash were recorded. Earlier mention of fertilizers referred to phosphate rock, Peruvian guano, marls, or organic manures. Imports of substantial quantities of kainite beginning in 1884 indicate the first extensive use of complete fertilizers as we understand the term today. The kainite averaged about 13 percent K_2O and was mixed with the other ingredients in proportions to give 1½ to 2 percent potash, about 9 percent available phosphoric acid, and about 2½ percent ammonia in the finished product.

The sulphate, muriate, and kainite imported in 1884 together contained approximately 28,000 tons of K_2O. By 1910 imports of the corresponding salts, used then chiefly in fertilizers, had grown to about 220,000 tons of contained K_2O with a declared value of about $10,000,000.

As previously mentioned, upheaval in the German industry induced by dissatisfaction with quota allotments within the syndicate and price cutting by strong independent producers resulted in passage of the German potash law of 1910 that brought the entire industry under complete Government control. Provisions of the law made it impossible for the independents to continue deliveries under the terms of their contracts with American buyers. After a period of chaos in the American market a settlement was reached through negotiations in which the State Department participated.

As a direct result of this distressing experience the American Government undertook a survey of domestic resources of potash-bearing materials with the avowed purpose of ending dependence on the German Government-controlled monopoly of this mineral commodity that was assuming greater importance yearly in the national economy.

Many potential sources of potash in the United States were known, but none offered commercial possibilities attractive enough to induce private capital to pioneer in their development. Vast deposits of silicate rocks containing 5 to 12 percent K_2O could not be utilized for lack of a cheap process for extracting the potash or converting it to soluble form that would be available as plant food. Extensive known deposits of rock salt suggested the possible association of beds rich in potash salts. Alkali lakes in arid regions of the West invited investigation. Vast kelp groves on the Pacific coast and various industrial wastes offered further possibilities.

In March 1911 Congress appropriated $20,000 to the Geological Survey and $12,500 to the Bureau of Soils for physical and chemical investigations of deposits of potash salts and other possible sources of potash, including the development of extraction processes. This appropriation to the Geological Survey was continued each year to 1926, and increasing amounts were appropriated to the Bureau of Soils until 1922.

During 1912 and the years immediately following the Geological Survey investigated natural brines in the salt lakes of California, Utah, Nevada, Nebraska, Texas, and other States and the saline deposits in dry lake beds; drilled salt deposits in Nevada and Texas; studied alunite deposits in Utah and other States and experimented on recovery of potash from alunite; examined the leucite rocks of Wyoming and other igneous rocks high in potash; and studied the salt beds of the Permian Basin in west Texas and eastern New Mexico, following the discovery in 1912, by Prof. J. A. Udden of the University of Texas, of potassium chloride in the water from a deep well drilled at Spur, Dickens County, Tex.

This discovery in Texas and the results of analyses of brine from Searles Lake, Calif., proved to be the most promising leads developed by the Survey's investigations. Brine samples collected in March 1912 at various points and from considerable depths in Searles Lake showed that an average of 6.78 percent of the total dissolved salts was potash (K_2O) corresponding to 10.73 percent potassium chloride. This lake, also known as "Borax Flat," for many years had been an important source of borax, and recovery of soda ash had also been projected. The American Trona Corporation was organized in 1913 to refine and market the various salts in the Searles Lake brine. A railroad was built from Searles on the Southern Pacific to the new town of Trona and a pilot plant constructed. The process first adopted proved to be unsuitable, and the plant was discarded. Further tests of a considerable volume of brine shipped to New York for the purpose resulted in the adoption of a new process. A new plant was constructed at Trona and a refinery at San Pedro, and production started in 1916. Although beset at first by technical and other difficulties this enterprise was successful and proved to be the most important domestic source of potash for many years.

The Bureau of Soils cooperated with the Geological Survey in its investigations of brines and bitterns and in addition gave special attention to a detailed study of the seaweeds, or giant kelps, of the Pacific coast, including surveys of the kelp groves to determine available tonnage and investigation of methods of harvesting the crop and recovering potash from this raw material. This phase of the Bureau's potash studies was pursued through the construction in 1917, at Summerland, Calif., of an experimental processing plant and its operation from August of that year to June 1921. According to J. W. Turrentine, who was in charge of these investigations, operations at this plant and others privately owned demonstrated the technical feasibility of utilizing kelp as a raw material for the manufacture of potash, iodine, kelpchar (a decolorizing carbon of exceptional qualities), and a long list of valuable chemical compounds, both organic and inorganic. The Bureau of Soils also studied the extraction of potash from silicate rocks, such as feldspars, Georgia shales, and New Jersey greensands; the recovery of potash from cement-kiln and blast-furnace flue dust; and the direct use of raw alunite, feldspars, and kelp as fertilizers.

Although a number of possible sources of potash investigated by the Government and by private agencies offered some promise and various experimental projects were under way, no potash actually had been produced when the outbreak of hostilities in Europe in 1914 threatened to interrupt shipments from Germany. Toward the end of the year American Potash, Inc., of Long Beach, Calif., made a small production from kelp that was hailed as signalizing the birth of the new potash industry.

On January 30, 1915, exportation of potash salts from Germany was stopped by embargo. The resulting rise in prices was eased somewhat by accumulated stocks in the United States, but these soon were exhausted and by the end of the year market quotations for 80-percent muriate had climbed to $500 a ton from the 1914 net price of $33.21. The incentive of extraordinary prices injected new energy into development of the domestic industry, and efforts were made to exploit nearly all the different sources that had been under investigation.

In 1915 five plants produced 1,090 tons of K_2O valued at $342,000 from natural brines at Jesse Lake in Nebraska and Owens Lake in California; from alunite at Marysvale, Utah; from cement-kiln dust at Riverside, Calif.; and from kelp at Long Beach, Calif. Activity in experimental work and construction of plants for extraction of potash from other sources increased. During the next 3 years hundreds of projects were launched. Although many were purely speculative promotions a large number were sound, earnest efforts to meet the existing emergency. The combined results were recorded in steadily mounting output of potash material that reached a maximum in

1918, when 128 producers reported 207,686 tons of crude potash containing 54,803 tons of K_2O.

Accounts of war-time potash developments were given in considerable detail by W. C. Phalen, Hoyt S. Gale, and W. B. Hicks in chapters of Mineral Resources of the United States for 1915, 1916, 1917, and 1918 issued by the United States Geological Survey. These publications contain descriptions of occurrences of potash-containing substances, government and private investigations and tests, plants, processes, and patents. Written contemporaneously and largely from first-hand information, they present an excellent record of the effect of the World War on the potash industry.

Signing of the armistice in November 1918 brought to a sudden halt a breathless industry proceeding at break-neck speed. Annual production capacity of plants in operation or under construction was estimated at 100,000 tons of K_2O, and the capital invested was reported to be about $25,000,000. Few plants had been fully paid for, and many had been operated only a short time or were still under construction. Following the armistice consumers ceased buying in anticipation of early resumption of foreign shipments at low prices, and producers were left at the year-end with nearly a third of their year's output on hand. Prices dropped from an average of $4 to $5 a unit to about $2.50 a unit, which was below the cost of production at many plants. By early 1919 nearly all plants had closed, and some had gone out of business. Producers made unsuccessful efforts to salvage the domestic industry by the usual expedient of protective legislation. However, conditions abroad were such that no immediate resumption of large-scale shipments was possible, and the anticipated influx of foreign potash failed to materialize. Prices were maintained at $2 to $2.75 a unit, and domestic output again found a ready market. Plants were reopened and production continued, but on a diminishing scale. Operators organized and continued to urge a tariff on potash, an effort foredoomed to failure because of the very high costs of most units of the industry and the fact that the chief consumers of potash are the farmers.

Substantial shipments first began to arrive from Germany and France in 1920. Prices, at first high, soon declined and by 1923 were below pre-war figures. As prices fell high-cost plants were forced out of business. Domestic production in 1921 reached the low point of 10,171 tons of K_2O. In 1922 only 12 plants reported production, and of these all but one produced potash as a comparatively insignificant byproduct of steel, cement, alcohol, beet-sugar, or chemical manufacture. The American Trona Corporation, working Searles Lake brine, manufactured muriate of potash as its principal product but also produced borax that helped bear the cost of operating the plant. The success of this company in solving the difficult technical problem of recovering merchantable products from the complex brine, and in steadily reducing operating costs and increasing output, accounted for the steady rise in domestic production for the next decade from the low point of 1921.

Post-war readjustment of the European industry was completed by an agreement (signed in 1924 and revised and extended in 1925) between the German Kalisyndikat and the French Société Commerciale des Potasses d'Alsace, that reestablished syndicate control of world markets. The announced policy of the new cartel was to endeavor to reduce prices by developing existing markets and seeking new ones—a policy agreeable to consumers but less pleasing to those endeavoring to establish a domestic industry.

The Franco-German agreement, restoring monopolistic control, accelerated the search for adequate domestic sources of cheap potash. The well-known geological similarity between the great Permian salt basin, which extends from central Kansas southward through Oklahoma, west Texas, and New Mexico, and the potash fields of Germany and Alsace, early suggested the occurrence of associated potassium salts, and the discovery in 1912 by Dr. J. A. Udden of potash in brine from a deep water well strengthened the belief that commercial concentrations of potash minerals would be found in that region. The discovery of oil and the subsequent rapid extension of wildcat drilling provided new information regarding the salt deposits. Drilling operations were followed closely by the United States Geological Survey and samples of drill cuttings obtained wherever possible.

From data thus obtained it soon became apparent that potash was distributed widely throughout the basin, but depth, thickness, and composition of potash-bearing strata could not be judged accurately from examination of sludge samples. Soluble salts might be lost, and depth and interval represented by a given sample were uncertain. The need for core drilling was evident, but the prospect of profitable return was insufficient to attract private capital to underwrite the heavy cost. The national interest at stake warranted the Federal Government in taking the lead. After several years of effort Senator Sheppard, of Texas, finally secured passage of a bill authorizing the appropriation of $100,000 a year for 5 years to be expended by the Geological Survey and the Bureau of Mines in exploration to determine the location, extent, and mode of occurrence of potash deposits in the United States. The bill was signed by the President on June 25, 1926. However, so many safeguards were provided to prevent private profit at public expense that the terms of the act had to be liberalized by amendment before drilling on or near private land was possible. The first appropriation of $100,000 was made to the Bureau of Mines for the fiscal year 1927. By agreement between the two bureaus the Geological Survey selected drilling sites and examined and tested cores; the Bureau of Mines negotiated all contracts and conducted drilling operations. The first hole was started February 21, 1927, and the drilling program was completed November 29, 1931. Twenty-four holes totaling 42,589 feet in depth were drilled. All but the first three were churn-drilled to the top of the salt beds and cored in the salt. Core-drilling totaled 21,839 feet 8 inches, and 21,315 feet 5 inches (97.6 percent) of the core was recovered. A saturated brine of potassium, magnesium, and sodium salts was used in core-drilling to avoid loss of soluble material contained in the cores. Thirteen holes were drilled in New Mexico, 10 in west Texas, and 1 in Utah. Of the $500,000 appropriated, $398,857.15 was spent for drilling, the balance being used over the 5-year period for supervision and for examining and testing the cores. All of the boreholes found potash, and many of them discovered beds of sufficient thickness and grade to be considered of possible commercial interest. The principal mineral found was polyhalite, the sulphate of potash, lime, and magnesia. Sylvite and carnallite, the chief minerals mined for potash in Germany and France, were found only in the Carlsbad area of New Mexico.

In 1925 sylvite was identified in cuttings from an oil and gas test about 25 miles southeast of Carlsbad drilled by Snowden & McSweeney, oil operators. The following year, on advice of their engineer, V. H. McNutt, a core test was put down by Snowden & McSweeney to check this discovery, with results so encouraging that the American Potash Co. was formed to explore intensively an area surrounding the discovery well. After 16 tests were drilled a four-compartment shaft was started in December 1929, and completed within a year at a depth of 1,062 feet. Workings were opened in a commercial bed of sylvite at 980 feet, and production started early in 1931. The first commercial shipment, in March 1931, averaged as mined 26.8 percent K_2O. The company was incorporated in 1930 as the United States Potash Co. It has been a steady shipper of manure salts since 1931 and of high-grade muriate since completion of its refinery in the fall of 1932.

The Potash Co. of America, formed in 1931 to explore for potash in New Mexico, after studying reports on Government tests, selected for prospecting an area that included the first and second tests drilled by the Government, in both of which thin beds of carnallite and sylvite were found. Fifteen core tests and several churn-drill holes located favorable ground, and a shaft was started in February 1933. Shipments of manure salts from this mine were begun in 1934, and it is understood that in the near future both mechanical concentration and the usual refining methods will be employed in the preparation of higher-grade products.

By 1933 the post-war developments briefly sketched had expanded domestic output from the 1921 low of 25,485 tons of material containing 10,171 tons of K_2O, produced at 20 small plants and byproduct operations, to 333,110 tons containing 143,378 tons of K_2O turned out by four producers. Due to unfavorable trade conditions, production in 1934 showed no increase, although capacity was considerably augmented by new construction and the beginning of shipments from the second New Mexico mine.

The search for domestic sources of potash adequate to supply national requirements at reasonable cost, begun by the Government in 1912, has brought results that justify the $2,000,000 expenditure of public funds over a 20-year period. Developed resources are ample for many years. Indicated reserves are large and doubtless will be multiplied by advancing technology. Existing plants can supply well over half the market and could be expanded quickly to meet all demands in an emergency. The World War potash famine that cost this country many millions of dollars will not be repeated.

To those agencies that have been instrumental in creating it, the industry seems worthy of preservation, and serious thought might well be given to some mild measures of protection, such as import quotas that would reserve a certain percentage of the American market for American producers without increasing the cost to consumers or barring imports. The disastrous effects of overdevelopment, that have dogged the industry from its earliest days, are held somewhat in check in Europe by cartels and international agreements—a method denied American producers. It is to be hoped that overdevelopment of domestic resources with its inevitable waste may be avoided.

The 1934 season was unsatisfactory and probably unprofitable to all producing factors in the potash trade. Efforts of Spain to find a market for her newly developed surplus combined with low-priced Russian offerings and other less tangible influences to demoralize the market and upset the price structure. Minimum published quotations for 1934 listed muriate at 40 cents a unit, less 12 percent, or 35.2 cents net for early summer delivery. Chiseling was suspected, and sales as low as 27 cents a unit were rumored. The outlook for 1935 seems brighter. Price lists for the 1935 season issued in May quote muriate at 40 cents a unit without discount, and the recently announced agreement between the Franco-German Syndicate and Spanish producers should lend stability to the market. It is rumored that Russia also has agreed to refrain from marketing her potash at destructive price levels. Evidence of coöperation between the principal suppliers of the American market is seen in the incorporation by the leading importers and the three chief domestic producers of the American Potash Institute, Inc., a research organization to promote efficient and profitable use of potash in crop production. Whether prices will remain at the initial level cannot be predicted. Stocks in the hands of consumers are probably large as a result of speculative purchases at low prices of 1934, but a spirit of moderate optimism can be sensed that was not in evidence a year ago.

For many years inducements in the form of price concessions have been offered for early summer purchases. The fact that new schedules for the 1935–36 season are net suggests that the suppliers may have in mind a possible boost in prices later in the year.

The following table, showing production and sales of domestic potash from the birth of the industry in 1915 through 1934, illustrates clearly the mushroom growth that accompanied high unit prices of the war-time boom, the precipitous post-war deflation, and the steady, sturdy growth of an economically sound industry from the liquidated remnants of the 1921 crash. The first and last columns, showing the number of plants and the average value of the product per unit of K_2O at the plant, are especially illuminating. The set-back experienced in 1934 was the result of extraordinary conditions and early resumption in the upward trend of domestic production may be expected. The low unit prices of 1934 heavily penalized low-grade material; and reduced shipments of manure salts accounted for the shrinkage in domestic sales. Sales of refined salts increased 4.6 percent over 1933.

Potash produced and sold in the United States, 1915–34

Year	Number of plants	Production: Crude potash (short tons)	Production: Available content of K_2O (short tons)	Sales: Crude potash (short tons)	Sales: Available content of K_2O (short tons)	Sales: Value f. o. b. plant: Total	Sales: Value f. o. b. plant: Per ton	Sales: Value f. o. b. plant: Per unit K_2O
1915	5	4,374	1,090	4,374	1,090	$342,000	$78.19	$3.14
1916	70	35,739	9,720	35,739	9,720	4,242,730	118.71	4.36
1917	95	126,961	32,573	126,961	32,573	13,980,577	110.12	4.29
1918	128	207,686	54,803	140,343	38,580	15,839,618	112.86	4.11
1919	102	116,634	32,474	166,063	45,728	11,271,269	67.87	2.46
1920	66	166,834	48,077	139,963	41,444	7,463,026	53.32	1.80
1921	20	25,485	10,171	10,337	4,408	447,859	43.33	1.02
1922	12	25,176	11,714	22,028	11,313	463,512	21.04	.41
1923	12	39,029	20,215	35,164	19,281	784,671	22.31	.41
1924	12	43,734	22,903	37,492	21,880	842,618	22.47	.39
1925	9	51,565	25,448	52,823	25,802	1,204,024	22.79	.47
1926	7	46,324	23,366	51,369	25,060	1,083,064	21.08	.43
1927	9	76,819	43,510	94,722	49,500	2,448,146	25.85	.49
1928	9	104,129	59,910	105,208	60,370	3,029,422	28.79	.50
1929	5	107,820	61,590	101,370	57,540	2,988,448	29.48	.52
1930	5	105,810	61,270	98,280	56,610	2,986,157	30.38	.53
1931	6	133,920	63,880	133,430	63,770	3,086,955	23.14	.48
1932	5	143,120	61,990	121,390	55,620	2,102,590	17.32	.38
1933	4	333,110	143,378	325,481	139,067	5,296,793	16.27	.38
1934	8	275,732	144,342	224,875	114,122	2,813,218	12.51	.25

The relation between consumption, unit value at the plant, and domestic sales from 1913 to 1934, inclusive, in terms of short tons of K_2O, is shown graphically in figure 122.

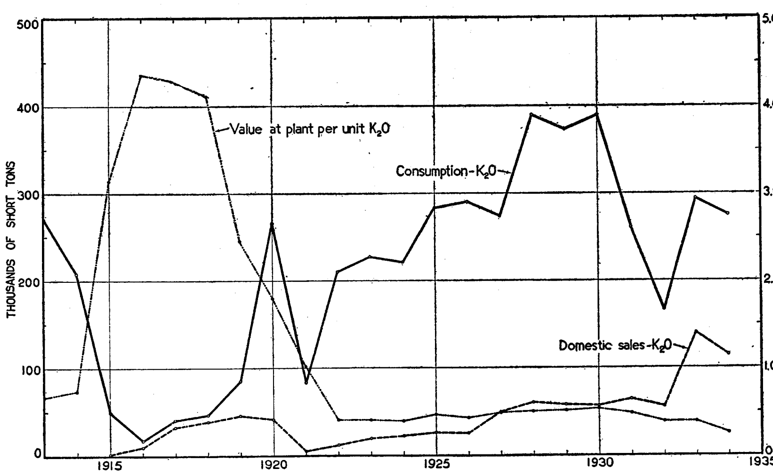

FIGURE 122.—Trends in domestic sales, consumption, and value of potash (K_2O), 1913–34.

Salient statistics of the industry for 1933 and 1934 are summarized in the following table.

Salient statistics of the potash (crude and refined potash materials) industry in the United States, 1933–34

	1933	1934
Production ... short tons	333, 110	275, 732
Sales:		
Short tons	325, 481	224, 875
Value at plant	$5, 296, 793	$2, 813, 218
Average per ton	$16. 27	$12. 51
Imports:		
Short tons	479, 429	486, 167
Value	$11, 816, 458	$11, 616, 918
Exports:		
Fertilizer material:		
Short tons	28, 086	27, 988
Value	$901, 931	$918, 169
Other:		
Short tons	1, 275	2, 121
Value	$301, 596	$466, 929

PRICES

At the beginning of the 1934–35 season uncertainty prevailing in the potash trade caused suppliers to postpone publication of price lists customarily issued on or about May 1. Importers quoted prices, for May only, on the basis of 1933–34 list less 10 percent, and domestic sellers offered muriate at the equivalent of 60 cents per unit of K_2O, less 10 percent, or 54 cents per unit. Buyers hesitated to purchase beyond immediate needs in anticipation of further price concessions when schedules for the 1934–35 season were issued. It was believed in some quarters that a sliding scale of discounts might be established, governed by the quantity purchased on a single order.

On June 1 California producers of muriate announced a price of 50 cents per unit of K_2O for June–December delivery, with a discount of 12 percent on orders placed prior to July 16 for delivery over the balance of the year, provided half the order was taken before October 1. On orders placed after July 15 and before October 1 a discount of 6 percent was allowed. The price was guaranteed against reduction prior to April 30, 1935. No other suppliers issued printed lists at that time, but it was rumored that importers were prepared to sell all forms of potash fertilizer salts except sulphate and double sulphate at the equivalent of 44 cents per unit of K_2O. Sulphate of potash was reported selling at $35 per ton and sulphate of potash-magnesia at $22.50 per ton.

When other potash sellers failed to follow their lead and no other price lists were published the California producers sent out a statement dated June 26 withdrawing and canceling their price schedule of June 1. Following this action prices were purely nominal for a period and business virtually was suspended. Sellers were reported willing to negotiate privately, but buyers apparently preferred to wait settlement of the price upset.

On July 7, leading importers sent out to the trade their initial price schedule for the 1934–35 season. Muriate, 30-percent manure salts, and 20 percent kainite were quoted at 50 cents per unit of K_2O; 14-percent kainite was priced at $9.70 per ton, sulphate at $35 per ton, and sulphate of potash-magnesia at $22.50 per ton. Discounts of 12 percent on orders placed before July 16 and 6 percent on orders before October 1 were allowed. The price with respect to muriate was identical with that for California muriate published June 1 and withdrawn later.

During July no other schedules were issued. Competition sharpened, and the market was thoroughly demoralized. It was stated freely, but could not be confirmed, that potash was available at 12 percent off list after July 16, the expiration date. Rumors persisted through September that all sorts of concessions, ranging from free warehousing to liberal discounts, were being offered buyers whereby net prices actually were lowered to about 30 cents per unit. So persistent a crop of rumors could have sprung only from wide disregard of the nominal schedule.

Official announcement on July 27 of a further price slash to 40 cents per unit for California muriate was quickly met by importers and one New Mexico producer who published new price schedules under date of August 1. List prices were as follows: Muriate of potash, all grades, 40 cents per unit of K_2O, equivalent to $20 per ton for muriate testing 50 percent K_2O; manure salts, minimum 30 percent K_2O, 43 cents per unit of K_2O, equivalent to $12.90 per ton for material testing 30 percent K_2O; high-grade kainite, minimum 20 percent K_2O, 43 cents per unit of K_2O, equivalent to $8.60 per ton for material testing 20 percent K_2O; kainite minimum 14 percent K_2O, $8.50 per ton; sulphate of potash, basis 90 percent K_2SO_4, $35 per ton; sulphate of potash-magnesia, basis 48 percent K_2SO_4, $22.50 per ton. Discounts were 12 percent from May 1 to July 16, 6 percent to October 1, and net thereafter to April 30, 1935. It is understood that guarantees of earlier contracts revised previous transactions to the minimum price and brought the bulk of potash sales for 1934 to around 30 cents per unit of K_2O, probably the lowest price at which potash has ever been offered in this country.

Following the final slash in prices that was met by all sellers the market steadied, but there was comparatively little business other than delivery on previously written contracts. After the turn of the year interest focused on probable price levels for the coming season and the possibility of understandings between competing interests that would stabilize the market at reasonable levels.

Initial schedules for the 1935–36 season, issued by all the principal sellers late in May, repeat the previous year's final base prices for muriate and manure salts but without discount, representing an increase of 13.6 percent from final settlement figures on purchases a year ago. Net quotations for early summer sales suggest the possibility of higher prices in mid-July or later in the year. Interesting variations in quotations on salts not produced in the United States are noted in the new schedules. Twenty percent kainite is raised from 43 to 50 cents per unit of K_2O, and 14-percent kainite is dropped from the list, perhaps because low unit prices have thinned the margin above transportation costs on this low-grade material to the vanishing point. Sulphate of potash and sulphate of potash-magnesia, after the initial drop in 1934 to $35 and $22.50 per ton, respectively, did not participate in further price slashes and were therefore considerably out of line with muriate and other salts. In the newly issued list (May 11, 1935) importers quote these salts at $29.85 and $19.75, respectively, thus approximately restoring the normal differential.

Base prices of foreign potash materials prevailing from 1926 to 1934, as supplied by N. V. Potash Export My., Inc., are given in the following table:

Quoted prices (subject to varying discounts) per short ton of different grades of potassium salts, c. i. f. Atlantic and Gulf ports, 1926–34

		Dec. 1, 1926, to Apr. 30, 1929	May 1, 1929, to Feb. 24, 1930	Feb. 25 1930, to Apr. 30, 1932	May 1, 1932, to Dec. 31, 1932 [1]	May 1, 1934, to Apr. 30, 1935 [2]
Sulphate, 90 to 95 percent K_2SO_4	in bags	$47.30	$47.75	$48.25	$47.50	$35.00
	in bulk	45.70	46.15	[3] 46.65		
Muriate, 80 to 85 percent KCl	in bags	36.40	36.75	37.15	37.15	22.00
	in bulk	34.80	35.15	35.55	35.55	20.00
Potash-magnesia sulphate (double manure salts), 48 to 53 percent K_2SO_4	in bags	27.25	27.50	27.80	27.80	22.50
	in bulk	25.65	25.90	[3] 26.20		
Manure salts, 30 percent K_2O	in bags	21.75	21.95	[3] 22.15		
	in bulk	18.75	18.95	19.15	19.15	12.90
Kainite, 20 percent K_2O	in bags	15.40	15.50	[3] 15.65		
	in bulk	12.40	12.50	12.65	12.00	8.60
Kainite, 14 to 16 percent K_2O	in bags	12.50	12.60	[3] 12.70		
	in bulk	9.50	9.60	9.70	9.70	8.50
Kainite, 12.4 percent K_2O	in bags	12.00	12.10			
	in bulk	9.00	9.10			

[1] The 1932 list price was continued through 1933 except for sulphate, 90 to 95 percent K_2SO_4, which was reduced to $42.15 per ton. Discounts were 10½ percent from May to Oct. 15 and 5 percent from Oct. 16 to Dec. 31.
[2] Discounts: 12 percent to July 16; 6 percent to Oct. 1; net thereafter.
[3] Price not quoted after May 1, 1931.

Base prices quoted by domestic producers of muriate of potash and manure salts over the period covered by the above table have been approximately equivalent to those published by importers. Prices given for the 1934–35 season are not exactly comparable with those of preceding years because they are based on a price per unit of K_2O, whereas quotations were formerly on the basis of the net minimum guaranteed percentage of K_2O with no charge for overtest.

CONSUMPTION AND USES

Apparent consumption of potash in the United States, calculated by subtracting exports from the sum of imports and domestic sales, was 680,933 short tons of material of all grades, equivalent to 275,000 tons of K_2O valued at $13,045,038 in 1934 compared with 775,549 short tons of salts containing 293,000 tons of K_2O valued at $15,909,-724 in 1933, a decrease of 12 percent in gross tonnage, 6 percent in K_2O, and 18 percent in value. Domestic producers supplied approximately 35 percent of the potash (K_2O) consumed in this country, a recession of about 6 percent of the market from the 1933 position, when 41 percent of domestic consumption was of domestic origin. About 92 percent of the total supply was used in the manufacture of fertilizers and 8 percent by the chemical industries. Figures on high-grade domestic muriate sold to the chemical trade are not available, as this material was not reported separately. Chemical salts amounting to 58,011 short tons, containing 23,798 tons of K_2O, were imported. Fertilizer salts sold for domestic consumption totaled 252,000 short tons of K_2O, of which approximately 97,300 tons (38.6 percent) was supplied by domestic producers. Low prices for potash fertilizer induced wider use of the high-grade salts, particularly muriate, and a corresponding falling off in sales of manure salts and low-grade kainite. Due perhaps to unfavorable price position sulphate was in somewhat lighter demand and accounted for 13.5 percent of fertilizer-salt imports compared with 14.9 percent in 1933.

PRODUCTION AND SALES

Domestic production of potash salts was 17 percent less in tonnage but slightly more in terms of K_2O than the hitherto high point reached in 1933. More of the material mined in New Mexico was refined than in the previous year, and output of high-grade muriate from California brines likewise was increased. Sales dropped 24,945 tons of K_2O (18 percent) compared with 1933, and stocks in the hands of producers at the end of the year were more than double the carry-over of the year before. Because of enlarged refinery capacity that will be increased further within the year by the anticipated construction of another plant in New Mexico and because of the unfavorable location of domestic sources with respect to principal markets on the Atlantic seaboard, future sales efforts may be expected to emphasize refined products. The low unit prices prevailing in 1934 made the manure-salts market unattractive to domestic shippers.

Sales of domestic potash material decreased 31 percent from 325,481 short tons in 1933 to 224,875 tons in 1934. The average grade (50.7 percent K_2O) was much higher than in 1933 (42.7 percent K_2O), and, as stated previously, the total sales in terms of potash decreased only 18 percent. Stated value f. o. b. plant fell from $5,296,793 in 1933, equal to $16.27 per ton of material and 38.1 cents per unit of K_2O, to $2,813,218 in 1934, equal to $12.51 per ton of material and 24.7 cents per unit of K_2O. This is the lowest average value at the plant, both per ton and per unit of K_2O, ever realized by domestic producers.

The total tonnage of potash materials as reported by producers is made up of both crude and refined salts containing varying quantities of K_2O; to avoid duplication, however, for refined material only the final weight is included rather than the larger tonnage of crude required in its production. Hence the domestic production of crude salts in 1934 is larger than shown in the following table although the figure truly represents the operators' output of both crude and refined salts without duplication. To reduce different grades of salts to a common denominator, the production and sales are also calculated in terms of K_2O content. The resulting figures are reliable indicators of trends in the industry, and are generally used in the trade because potash commonly is sold on the K_2O basis.

Production and sales by States and by sources cannot be given without disclosing individual output. Production and sales of potassium salts and stocks in the hands of producers for the past 5 years are summarized in the following table:

Potassium salts produced, sold, and in stock in the United States, 1930–34

Year	Production			Sales				Stocks		
	Number of plants	Potassium salts (short tons)	Equivalent as potash (K_2O) (short tons)	Number of plants	Potassium salts (short tons)	Equivalent as potash (K_2O) (short tons)	Value f. o. b. plant	Number of plants	Potassium salts (short tons)	Equivalent as potash (K_2O) (short tons)
1930	5	105,810	61,270	4	98,280	56,610	$2,986,157	5	20,550	11,000
1931	6	133,920	63,880	6	133,430	63,770	3,086,955	3	20,000	10,500
1932	5	143,120	61,990	5	121,390	55,620	2,102,590	3	41,000	28,000
1933	4	333,110	143,378	4	325,481	139,067	5,296,793	4	46,943	20,891
1934	8	275,732	144,342	8	224,875	114,122	2,813,218	4	95,844	50,066

GOVERNMENT ACTIVITIES

No new activities in relation to potash were undertaken by Government agencies during the year. The Bureau of Mines, continuing its experimental work on methods of extracting potash and manufacturing various potash salts from the different minerals occurring in the saline deposits of the Southwest, successfully applied mechanical concentration methods to the treatment of crude sylvinite for the separation of sylvite (potassium chloride) from halite (sodium chloride) and other impurities. The material treated was crude potash ore from Carlsbad, N. Mex., containing about 40 percent sylvite and 60 percent halite. Over 96 percent of the potassium chloride in the ore was recovered in a concentrate containing 95 percent KCl. This new development, part of which was conducted in cooperation with the Potash Co. of America, is a mechanical rather than a chemical process. High-grade concentrates were made with good recoveries by three methods: Tabling and flotation; tabling an agglomerated feed, supplemented by flotation; and all flotation. Sylvite and halite are both soluble in water, the medium usually employed in gravity separation, and the difference in their specific gravities is only 0.16. By using saturated brine, solution of the minerals was avoided and the difference in their relative weight was increased, thus facilitating their separation. It was discovered that results were much improved by treating the ore with crude oil and a sulphated alkyl alcohol reagent before tabling. The oiling caused the particles of potassium chloride to stick together, while the other minerals were unaffected. Agglomeration of the potassium chloride accelerated the gravity separation and made it possible to obtain both a high recovery and an exceptionally pure product. The method commonly employed to refine ore of this nature involves dissolving the salts in hot water and precipitating the potash by cooling the solution. The precipitate obtained by this method is a very high-grade potassium chloride; but the process consumes much heat, requires expensive equipment, and is costly to operate. The application of the newly discovered method of gravity concentration promises considerable reduction in the cost of manufacturing an acceptable grade of muriate of potash.

The Bureau of Chemistry and Soils continued investigation of methods of extracting potash from silicate minerals, of which enormous deposits are found in the United States. Announcement was made that Georgia shale and wyomingite can be extracted with hydrochloric acid, yielding a solution of such concentration that a high percentage of alumina, potassium chloride, and ferric chloride can be precipitated. Selective hydrolysis of the precipitated salts yields potassium chloride and alumina, with recovery of hydrochloric acid. A process also was developed for converting potassium chloride to potassium sulphate, with production of hydrochloric acid that can be applied to phosphate rock to yield dibasic calcium phosphate. The efficiency of sulphuric acid employed in this process is twice that realized in superphosphate manufacture.

The Geological Survey, through administration of the mineral leasing laws and regulations, supervised development and production of potash on public land leases and exploration by drilling on a number of prospecting permits. The Survey continued to receive and analyze samples of potash from drill cuttings and other sources, particularly from wells drilled for oil in the Permian Basin area underlain by salt deposits. On August 3, 1934, an order was issued suspending the granting of potash permits or leases for 90 days, and on November 3 the suspension was extended to April 5, 1935.

REVIEW BY STATES

No new sources of potash were drawn upon for the 1934 output. As in 1933, California brines, New Mexico saline deposits, and distillery waste supplied most of the domestic production. In addition some potash was recovered from cement-kiln dust, and small lots of cotton-boll ashes, alunite, and other potash-bearing rocks were sold. The principal producers were the American Potash & Chemical Corporation, 70 Pine Street, New York, and Trona, Calif.; United States Potash Co., 342 Madison Ave., New York, and Carlsbad, N. Mex.; Potash Co. of America, Mercantile Trust Building, Baltimore, Md., and Carlsbad, N. Mex.; United States Industrial Chemical Co., Inc., 60 East Forty-second Street, New York, and Baltimore, Md.; and North American Cement Corporation, Baltimore Trust Building, Baltimore, and Security, Md. The Potash Co. of America was the only addition to the list of shippers during the year.

California.—The American Potash & Chemical Corporation continued to manufacture potassium chloride, borax, soda ash, and salt cake from Searles Lake brine at Trona. Its recently enlarged refinery is said to have an annual capacity of around 180,000 tons of high-grade muriate.

New Mexico.—The United States Potash Co. completed its second shaft at a depth of about 1,000 feet late in 1933. The two shafts are 2,200 feet apart. Capacity of the refinery (situated near the Pecos River about 16 miles from the mine) was increased during 1934 to about 400 tons per day, or approximately 140,000 tons per year, of muriate containing less than 1 percent impurities. New construction at the refinery included a warehouse building 80 feet wide by 250 feet long, with no inside pillars. Mine and refinery are connected by a tram-road owned by the company. The mine is now equipped to handle 2,000 tons a day.

The Potash Co. of America in 1934 began shipment of manure salts from its mine 20 miles northeast of Carlsbad. The sinking of a second shaft was begun in October. The first shaft is 1,100 feet deep, and it is expected that the second shaft will be completed at about 1,050 feet, at which depth it will have penetrated the same beds now being worked. The new shaft will facilitate operations greatly and considerably enlarge the capacity of the mine. Completion is expected in the summer of 1935. Exploration of the company holdings by drilling was continued during the year.

Other companies active in exploration for potash in New Mexico during 1934 were the General Potash Co., the Texas Potash Corporation, the New Mexico Potash & Chemical Co., the Carlsbad Potash Co., and the Independent Potash & Chemical Co.

The General Potash Co., of Denver, which appears to be the successor or subsidiary of the Texas Potash Corporation, of Denver, filed with the Securities and Exchange Commission a registration statement supporting its proposal to issue $600,000 of common stock having a stated value of $10 per share. The statement was withdrawn later. Rumored consolidation of the General Potash Co. with the Independent Potash & Chemical Co., or acquisition of rights in the Lommasson permit recently acquired by the latter company from the New Mexico Potash & Chemical Co., so far have failed to materialize.

Drilling was continued in 1934 by the New Mexico Potash & Chemical Co., which sunk a second test on its Lommasson permit, and by the Texas Potash Corporation, the Carlsbad Potash Co., and Kroenlein and associates.

Maryland.—At Baltimore, the United States Industrial Chemical Co. continued to recover byproduct potash by incineration of the residue from alcohol distillation. Char from the bottom of the incinerator containing about 33.5 percent K_2O is marketed as "vegetable potash", and dust settled out of fumes from the top of the incinerator averaging about 53.5 percent K_2O is sold as sulphate-muriate.

The North American Cement Corporation by fractional precipitation of cement-kiln dust recovered a product containing about 22 percent K_2O, mostly in the form of sulphate. A small amount of low-grade residue carrying about 5 percent K_2O also was sold. The plant is at Security, near Hagerstown.

Utah.—A few tons of alunite were shipped from Marysvale to a fertilizer manufacturer in Los Angeles for use as a filler for fertilizer. Announcement by the Bohn Aluminum & Brass Corporation of a new process for manufacturing aluminum from alunite ore, with potash as a byproduct, and reports that the process would be utilized to exploit the alunite deposits at Marysvale caused a stir in Utah mining circles, but no further developments have been reported.

IMPORTS AND EXPORTS

Imports of potash materials for consumption totaled 486,167 short tons, an increase of 1 percent over imports of 479,429 tons reported in 1933. The average grade was somewhat higher, the total contained K_2O amounting to 178,533 tons, an increase of 6,679 tons (4 percent) from the preceding year. Fertilizer salts accounted for 88 percent of the potash (K_2O), and 12 percent was contained in chemical salts.

The big play given muriate in the 1934 market was reflected in an increase of 24,000 tons in the quantity of muriate entered. Imports of 20-percent kainite also increased, but imports of other important fertilizer salts declined. The average declared value of imported fertilizer salts per unit of K_2O was 50.2 cents. The average price obtained for material sold probably was well under 40 cents.

The quantity, average grade, and total declared value of potash salts imported for consumption in 1933 and 1934, classified by uses and the approximate K_2O equivalent of potash salts imported annually for the past 5 years, are shown in the following tables.

Potash materials imported for consumption in the United States, 1933–34

Material	Approximate equivalent as potash (K_2O) (percent)	1933				1934			
		Short tons	Approximate equivalent as potash (K_2O)		Value	Short tons	Approximate equivalent as potash (K_2O)		Value
			Short tons	Percent of total			Short tons	Percent of total	
Used chiefly in fertilizers:									
Kainite	14.0	48,307	6,760	3.9	$359,605	21,413	2,998	1.7	$170,906
	20.0	65,921	13,180	7.7	608,721	107,275	21,455	12.0	945,017
Manure salts	30.0	126,696	38,010	22.1	1,329,423	87,675	26,303	14.8	1,028,958
Muriate (chloride)	52.0	118,203	61,470	35.8	3,791,789	142,200	73,944	41.4	3,671,857
Potash-magnesia sulphate	27.0	15,445	4,170	2.4	348,780	20,957	5,658	3.2	438,292
Sulphate	50.0	50,999	25,500	14.9	1,913,110	48,242	24,141	13.5	1,511,705
Other potash fertilizer material [1]	60.0	-------	-------	------	-----------	394	236	.1	2,551
	-------	425,571	149,090	86.8	8,351,428	428,156	154,735	86.7	7,769,286
Used chiefly in chemical industries:									
Bicarbonate	46.0	148	68		20,137	102	47		16,795
Bitartrate (argols)	20.0	6,747	1,349		720,683	6,989	1,398		884,582
Bitartrate (cream of tartar)	25.0	1	(2)		165	(3)	(3)		69
Bromide	39.6	6	2		2,409	2	1		1,047
Carbonate, crude	61.0								
Carbonate, crude or black salts	50.0	6,738	4,110		662,784	6,504	3,902		802,265
Carbonate, refined	67.0								
Caustic	80.0	3,367	2,694		394,267	2,008	1,606		259,237
Chlorate and perchlorate	36.0	6,838	2,462		576,240	5,401	1,944		594,243
Chromate and bichromate	40.0	1	(4)	13.2	417	(4)	(4)	13.3	5
Citrate	43.0	4	2		2,164	-------	-------		--------
Cyanide	70.0	43	30		31,352	40	28		32,517
Ferricyanide (red prussiate)	42.0	58	24		27,723	51	21		26,132
Ferrocyanide (yellow prussiate)	44.0	9	4		2,648	4	2		1,496
Iodide	28.0	1	(5)		3,451	4	1		11,738
Nitrate (saltpeter), crude	40.0	28,664	11,466		880,493	35,408	14,163		1,071,498
Nitrate (saltpeter), refined	46.0	936	431		73,987	1,288	592		97,895
Permanganate	29.0	103	30		20,242	56	16		12,125
Rochelle salt	22.0	18	4		2,678	-------	-------		--------
All other	50.0	176	88		43,190	154	77		35,988
	-------	53,858	22,764	13.2	3,465,030	58,011	23,798	13.3	3,847,632
Grand total	-------	479,429	171,854	100.0	11,816,458	486,167	178,533	100.0	11,616,918

[1] Chiefly wood ashes from Canada.
[2] 413 pounds.
[3] Less than 1 ton.
[4] Quantity of bichromate imported was as follows—1933: 1,892 pounds, approximate equivalent as K_2O, 757 pounds; 1934: 22 pounds, approximate equivalent as K_2O, 9 pounds.
[5] 617 pounds.

Approximate equivalent as potash (K_2O) of potash-bearing materials imported for consumption in the United States, 1930–34, in short tons

1930	342, 454	1933	171, 854
1931	214, 785	1934	178, 533
1932	113, 505		

The following table showing potash shipments from various countries to the United States for import is not indicative of original sources, since import statistics record only the country from which the last shipment was made. Many of the countries listed produce no potash, and lots credited to them are merely transshipments. Imports from Germany and Netherlands (320,490 tons), largely if not wholly of German origin, constitute 66 percent of the total. Material of French origin (36,325 tons) entered from France and Belgium, accounted for 7 percent, and 76,690 tons (16 percent) came from Spain. Russia increased her shipments to the United States from 123 tons valued at $3,857 in 1933 to 15,013 tons valued at $323,037 in 1934.

Potash materials imported into the United States in 1934, in short tons [1]

[The figures in parentheses in the column headings indicate in percent the approximate equivalent as potash (K_2O)]

Country	Muriate (chloride) (52)	Sulphate (50)	Potash-magnesia sulphate (27)	Manure salts (30)	Kainite		Bitartrate	
					(14)	(20)	Argols or wine lees (20)	Cream of tartar (25)
Africa: Algeria and Tunisia							481	
Argentina							935	
Austria								
Belgium	5, 169	3, 396		7, 935	3, 196	7, 052	1, 350	
Canada	4, 103	58					53	
Chile							99	
China								
Czechoslovakia								
Finland								
France	2, 649	1, 644	134	2, 733	606			
Germany	64, 117	28, 503	20, 621	36, 220	8, 123	46, 555		([2])
Greece							36	
Hong Kong								
Italy							2, 231	
Japan								
Netherlands	21, 536	14, 022	202	21, 401	3, 050	33, 201		
Palestine	924							
Peru							2	
Portugal							711	
Spain	39, 728	619		10, 247	4, 538	20, 467	1, 091	
Sweden								
Switzerland								
U. S. S. R. (Russia in Europe)	3, 974			9, 139	1, 900			
United Kingdom								
	142, 200	48, 242	20, 957	87, 675	21, 413	107, 275	6, 989	([2])
Approximate equivalent as potash (K_2O)	73, 944	24, 141	5, 658	26, 303	2, 998	21, 455	1, 398	([2])

[1] Data on total imports during 1934 may not be strictly comparable with figures published in previous reports of this series due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in the system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

[2] Less than 1 ton.

Potash materials imported into the United States in 1934, in short tons—Continued

Country	Caustic (80)	Carbonate (61)	Cyanide (70)	Nitrate (saltpeter), crude (40)	Chlorate and perchlorate (36)	All other (48)	Total	
							Short tons	Value
Africa: Algeria and Tunisia							481	$67,279
Argentina							935	65,207
Austria						10	10	4,561
Belgium	86					1	28,185	438,923
Canada	25			502	5	393	5,139	133,390
Chile				25,300			25,399	589,522
China		3				1	4	398
Czechoslovakia		1,175				51	1,226	144,896
Finland					46		46	4,481
France					283	1	8,050	352,337
Germany	1,801	4,226	40	9,606	4,600	1,580	225,992	5,624,476
Greece							36	4,152
Hong Kong		6					6	893
Italy							2,231	317,305
Japan					1	4	5	11,807
Netherlands		1,080				6	94,498	1,660,244
Palestine							924	27,189
Peru							2	394
Portugal							711	88,197
Spain							76,690	1,671,510
Sweden	96	2			267		365	54,871
Switzerland					199	(2)	199	26,713
U. S. S. R. (Russia in Europe)							15,013	323,037
United Kingdom		12				8	20	5,136
	2,008	6,504	40	35,408	5,401	2,055	486,167	11,616,918
Approximate equivalent as potash (K_2O)	1,606	3,902	28	14,163	1,944	993	178,533	

[2] Less than 1 ton.

Exports of potash fertilizer material fell off slightly in tonnage but gained $16,238 in value compared with 1933. Again, as in 1933, the best customer was Japan. California plants, relatively close to Pacific tidewater, enjoy a favorable position with respect to oriental markets. Since 1933 all potash fertilizer materials have been exported under a single classification.

Potash fertilizer material exported from the United States, 1933–34, by destinations

Destination	1933		1934	
	Short tons	Value	Short tons	Value
Brazil	1	$49		
Canada	7,223	239,972	4,753	$150,535
Colombia			1	155
Cuba	467	16,534	299	9,296
Dominican Republic			2	86
Guatemala	3	215		
Honduras	32	1,464	34	1,289
Jamaica			20	460
Japan	18,948	599,982	22,784	752,327
Panama			1	36
Philippine Islands	1,411	43,662	50	1,335
Salvador			6	400
Trinidad and Tobago			20	731
Venezuela			18	1,513
Virgin Islands of United States			(1)	6
West Indies ("Other British")	1	53		
	28,086	901,931	27,988	918,169

[1] Less than 1 ton.

Exports of potassium salts other than fertilizer material increased 66 percent in quantity and 55 percent in value. They are shown in the following table:

Potassium salts (not fertilizer) exported from the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	1,256	$498,774	1933	1,275	$301,596
1931	1,158	370,935	1934	2,121	466,929
1932	887	241,179			

WORLD PRODUCTION

Official figures of production for 1934 are available only for Germany, France, and the United States. These three countries alone produced 1,840,000 metric tons of K_2O. The combined output of Spain, the U. S. S. R., Poland, and Palestine probably was around 250,000 tons, bringing the world total to approximately 2,100,000 metric tons of K_2O compared with about 1,740,000 tons in 1933, an increase of approximately 20 percent. Production appears to have exceeded sales by 10 to 15 percent. Germany produced over 60 percent of the world supply. France came second, with about 18 percent of the total, and the United States probably was third with about 6 percent. Available official figures for world production of potash materials from 1930 to 1934 are given in the following table.

World production of potash minerals and equivalent K_2O, 1930–34, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country and mineral [1]	1930		1931		1932		1933		1934	
	Output	Equivalent K_2O	Output	Equivalent K_2O	Output	Equivalent K_2O	Output	Equivalent K_2O	Output	Equivalent K_2O
Chile, perchlorate of potash [2]	2,409	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Chosen, alunite	11,708	(3)	14,183	(3)	16,320	(3)	26,863	(3)	(3)	(3)
Egypt, crude potassium salts	----	----	1	(3)	8	(3)	4	(3)	(3)	(3)
Ethiopia, potassium salts	[4] 1,500	(3)	----	----	----	----	(3)	(3)	(3)	(3)
France (Alsace), crude potassium salts	3,135,170	[5] 506,370	2,196,740	[5] 367,879	1,920,000	[5] 326,500	1,890,600	[5] 332,000	2,054,400	[5] 378,900
Germany, crude potassium salts:										
Carnallite [6]	1,867,548	179,087	1,059,278	100,985	635,940	61,245	642,445	65,285	} 9,612,241	1,330,218
Kainite, sylvinite, and hartsalz	10,094,703	1,429,427	6,992,122	976,657	5,779,591	810,109	6,720,326	960,829		
India (British), nitrate of potash [7]	4,700	2,200	6,600	3,100	9,100	4,400	10,060	4,900	(3)	(3)
Italy:										
Alunite	825	83	990	102	700	71	534	51	(3)	(3)
Leucite rock	41,200	(3)	16,000	(3)	44,000	(3)	(3)	(3)	(3)	(3)
Palestine, crude potassium salts [8]	6,000	1,200	13,000	2,600	10,200	5,100	15,000	7,500	(3)	(3)
Poland, crude potassium salts:										
Kainite	100,783	10,209	59,120	7,165	44,692	4,759	62,537	6,979	(3)	(3)
Sylvinite	204,826	45,021	202,199	45,576	231,966	52,285	236,608	70,391	(3)	(3)
Spain:										
Alunite	3,864	(3)	23,985	(3)	----	----	----	----	(3)	(3)
Crude potassium salts	286,436	28,644	250,087	28,116	409,888	54,811	623,941	90,637	(3)	(3)
Potassic earth	900	(3)	1,100	(3)	750	(3)	500	(3)	(3)	(3)
U. S. S. R. (Russia), crude potassium salts [9]	120,000	(3)	120,000	(3)	(3)	(3)	800,000	(3)	(3)	(3)
United States, crude potassium salts	95,989	55,583	121,490	57,951	129,836	56,236	302,191	130,070	250,139	130,944

[1] In addition to countries listed Persia is reported to produce a small quantity of nitrate of potash near Hamadan, but statistics of production are not available.
[2] Produced at nitrate plants from caliche. It is reported that crude potash salts are mined in Chile at the deposits near Iquique and in the Salar de Atacama, but no figures of production are available.
[3] Data not available.
[4] Muriate of potash produced in Eritrea from crude salts mined in Ethiopia.
[5] Figures relate to merchantable products.
[6] Includes some natural kieserite.
[7] Estimated production (Imperial Institute, London).
[8] Extracted from waters of the Dead Sea.
[9] Produced at Solikamsk potash mines.

FOREIGN DEVELOPMENTS

France.—The output of French mines in 1934 exceeded that of any year since 1929. Alsatian mines and plants produced 2,054,000 metric tons of merchantable potash products containing the equivalent of 378,900 tons of K_2O, an increase of about 164,000 tons of material and 47,000 tons of potash from 1933. The average grade was somewhat higher than in 1933, reflecting a larger proportion of high-grade salts. About 1,500,000 tons came from the Government-owned mines and about 600,000 tons from mines of Kali-Sainte-Therèse.

Domestic prices were reduced an average of 8 percent in May 1934 following the decree of April 28, 1934, guaranteeing greater protection for the domestic industry. Prices on the export market were affected by competition.

It was reported in the French press that Blodelsheim mines, along with Mines Domaniales (the State-owned mines) and Kali-Sainte-Therèse would receive sales allotments irrespective of amounts of annual deliveries, the portion allotted to Blodelsheim being fixed by arbitration by the minister of public works. To avoid capital investment for equipping the Blodelsheim mines, the other two groups were to furnish Blodelsheim's share to the sales cartel and to pay Blodelsheim the net profit derived from salts delivered on its behalf.

Germany.—Sales of the Potash Syndicate in 1934 totaled 1,220,000 metric tons of K_2O compared with 937,000 tons in 1933 and 837,000 in 1932. The 1934 turnover was only about 13 percent under the 1929 peak of 1,400,000 tons. Production was 1,330,000 tons, or 110,000 tons in excess of sales. With growing competition from Spain and the United States in important foreign markets and the recent addition of Russia to the roster of potash-exporting nations, the German industry has come to rely more and more on the home market, which absorbed 66 percent of its sales in 1933. Foreign sales have continued to expand moderately, but profit margins have shrunk severely.

In an effort to stimulate domestic consumption further, domestic prices were reduced, effective October 16, 1934, by 11 to 38 percent according to grade, and to simplify market operations the number of grades was reduced to only five. Uniform freight rates to be paid by domestic consumers were established to permit delivery at a uniform fixed price anywhere in Germany. This resulted in price increases in some regions in and near central Germany but was generally favorable to the great agricultural districts. The new schedules will stimulate the sale of high-analysis salts. The system formerly in force of securing debts for fertilizer deliveries by prior liens on farmers' crops was reestablished during the year. The average unit values obtained by the syndicate fell during November to an all-time low. The output of German mines increased about 300,000 tons of K_2O compared with 1933. Shipments from Germany and the Netherlands (probably of German origin), amounting to 320,490 short tons with a declared value of $7,284,720, accounted for 66 percent of imports into the United States in 1934.

The four German potash-byproduct cartels (magnesium chloride, bitter salts, bromine, and bromine salts), all expiring at the end of 1934, were continued 9 years to December 31, 1943, with the exception of that for bromine salts, for which extension was limited to 1 year, owing to unsettled trade conditions affecting this product. The influence of the powerful Wintershall group in the potash industry was strengthened further by acquisition of one-third of Burbach Kaliwerke A. G. in return for financial assistance.

Italy.—Trade Commissioner Elizabeth Humes reports that the Soc. Italiano Potassio Marino, with the assistance of the Italian Government, is operating on a commercial scale, at Massaua on the Red Sea, the Niccoli process for extracting potash salts from concentrated sea brine. It is alleged that concentrated brine obtained by solar evaporation can be processed to yield kainite or potassium magnesium sulphate, with sodium chloride or magnesium chloride as coproducts. Potash consumption in Italy is relatively unimportant, amounting to only 15,856 metric tons K_2O for the 1933–34 season.

Netherlands.—Holland, with its dense population and small, intensively cultivated land area, is a large consumer of all kinds of fertilizer materials. Supplies of potash formerly came from Germany, France, and Poland. Large-scale offerings from Spain first appeared in 1933, and in 1934 both Spain and Russia competed actively for a share of the market. Competition led to drastic price cuts, which are said to have induced increased consumption. Reported negotiations for larger purchases from Russia are complicating the situation still more.

Palestine.—Judgment for the defendants in the action assailing the validity of the concession held by Palestine Potash, Ltd., for extraction of chemicals from water of the Dead Sea, was given July 17, 1934, by Justice Roche in the King's Bench Division of the High Court of London. Plaintiffs contended title granted them in 1910 by the Sultan of Turkey invalidated title of the defendants under a grant by the High Commissioner of Palestine in 1930. As English courts lacked jurisdiction over real property in another land the suit could be based only on a plea for enforcement of a contractual or equitable obligation on the defendants. No evidence of such obligation being presented, judgment was given by default.

According to Vice Consul Joseph L. Brent, Jerusalem, Palestine Potash, Ltd., will seriously exploit the south end of the Dead Sea, reputedly richer in salts of economic value than the north end, where the company's present evaporation fields and works are situated. Erection of a sulphuric acid plant for production of potassium sulphate from KCl is contemplated. The company recently added 150,000 £1 shares to its registered capital of 400,000 pounds and is reported planning a further increase.

The potash and bromine in the waters of the Dead Sea constitute the only noteworthy occurrence of these salts within the British Empire. The British Government has obtained the right of preference for the entire output in the event of war. Potash from Palestine is sold largely in Europe, although 924 tons of muriate were imported into the United States in 1934. The bromine factory has a daily capacity of 3 tons of refined bromine, which is disposed of largely in the British market

Poland.—Since consummation of the 5-year commercial agreement between the Franco-German Syndicate and the Polish Tesp (Society for the Exploitation of Potassium Salts) in March 1932 no Polish potash has been offered in the American market. By the terms of this agreement the Polish market was reserved for Polish producers who, in addition, received a quota of 4 percent of syndicate sales in the world market. For the 12-month period November 1, 1933 to October 31, 1934, sales of potash salts are reported to have increased 14 percent to 38,000 tons and sales of kainite 30 percent to 78,000 tons.

Polish producers have introduced a new fertilizer salt under the trade name "Kalimag". It is described as a mixture of 54 percent magnesium sulphate and 34 percent potassium sulphate with about 6 percent insoluble material and not above 3 percent sodium chloride. Because of the low chlorine content it is said to be especially suitable for tobacco, vegetables, fruit, and potatoes used in the manufacture of alcohol. Sales during 1934 totaled 3,134 metric tons.

U. S. S. R.—During 1934 Russian potash was sold in many foreign markets, including the United States, Canada, Holland, Austria, Czechoslovakia, and Japan. Exports totaled 146,793 tons, of which 36,811 tons were refined muriate and 109,982 tons crude salts. The crude salts included kainite and 30 percent manure salts. The reported production of potassium chloride by the Solikamsk plants during 1934 was 323,000 metric tons compared with 73,000 tons in 1933. Shipments to the United States totaled 15,013 short tons, equivalent to approximately 5,000 tons of K_2O.

When initial installations planned for the potash mines are completed in 1935 a total capital investment of 155 million rubles will have been made. Now that the Solikamsk mines are reputedly producing 3,500 tons of crude salts per day the Soviets are said to contemplate extending sales to western European markets as well as those of the Far East. The Leningrad Port Authority is constructing on Turuchatny Island a new warehousing and loading center for the export of potash salts. Russia is understood to have obtained large contracts with Finland at prices below those of the Franco-German Syndicate. An agreement with Czechoslovakia provides for exchange of products of her iron industry for Russian potash. Twelve thousand tons of potash salts were shipped to Czechoslovakia in 1934.

The Central Commission on the Natural Reserves in the U. S. S. R. has estimated the Solikamsk potash deposits at 16,000,000,000 metric tons, extending over a prospected area of 1,500 square kilometers. The commercial reserves are estimated at 600,000,000 tons. Further potash deposits are reported in the region of Orenburg. They are reported to surpass the deposits of Solikamsk in quality and abundance but are not situated advantageously for export. It is said these deposits could be developed for the production of potassium sulphate, none of which is produced in Russia at present and for which there is a considerable demand.

It is reported that a new potash bed is now being developed in the Solikamsk district. A complete plant for exploitation and treatment, including utilization of residues, is being provided. The projected output is said to be 3,000,000 tons of sylvinite a year, but only refined salts will be delivered.

Reports from Moscow state that the first shaft at Berezniky has struck the potash zone at a depth of 245 meters. The first stratum, 4 meters thick, is of better quality than that of the first plant at Solikamsk. It is planned to obtain metallic magnesium from the magnesium salts. Large deposits of saltpeter have been discovered in Russian central Asia (formerly Bokhara). The deposit is said to cover an area of 422 hectares.

Spain.—Agreement has been reported between the Franco-German Syndicate and the Spanish producers whereby the latter will receive an export quota of about 14 to 16 percent in the syndicate, which will comprise virtually all producers in Europe. About half of the Spanish quota, or almost 8 percent of the total exports of the syndicate, will accrue to the leading Spanish producer, the Union Espanola de Explosivos, and the main part of the balance to the Potasas Ibericas, S. A., the second largest producer in Spain. Several previous attempts to reach such an agreement were unsuccessful. This development will end competition that has tended to unsettle the market during the past 2 years and has been largely responsible during 1934 for trade conditions unsatisfactory to all producers.

Spanish exports of potash materials have increased from 25,649 metric tons in 1931 to 267,304 metric tons in 1934, the latter figure representing an increase of 70,000 tons from the preceding year. Exports to the United States in 1934 amounted to 76,690 metric tons compared with 67,235 tons in 1933. Spanish production is divided among the three principal producing companies in about the following proportions: Union Espanola de Explosivos, 46.5 percent; Potasas Ibericas, S. A., 36 percent; Minas de Potasa de Suria, S. A., 17.5 percent. Union Espanola de Explosivos is reported to have increased the daily output of its mines near Cardona to 1,675 tons. This company was financed originally by British capital. Its products are handled in the United States by H. J. Baker & Bro., 271 Madison Avenue, New York. Potasas Ibericas, S. A., the newest and the second largest producer operates mines near Sallent. This company is reputedly controlled by French capital, principally the Mirabeaud mining group. The factory of Potasas Ibericas, S. A., is said to be handling 750 tons per day of material averaging 22 percent potash (K_2O). Rumors that this company intends to issue new shares have been denied. It is represented in the United States by International Selling Corporation, 70 Pine Street, New York. Minas de Potasas de Suria, S. A., the oldest of the group, is said to be financed by Belgian Solvay interests. This company participates in the Franco-German agreement through affiliation of its sales agent, Potasas Reunidas, S. A., of Madrid, with N. V. Potash Export My. of Amsterdam, sales agent for the syndicate.

It is reported that a German group has decided to undertake the development of potash deposits near the Cardona deposits of Union Espanola de Explosivos.

Owing to the success of previous borings for potash the Spanish Government has appropriated extensive potash fields in Catalonia, which it may either exploit itself or lease to private companies. It is said that another potash bed, discovered in Balsareny, also in Catalonia, is to be exploited by a private company financed to a considerable extent by American capital.

A reciprocal agreement to balance the trade during 1934 between Denmark and Spain provided for the issuance of exchange certificates for the importation into Denmark of 10,000 metric tons of Spanish potash independent of previous importations during 1934. The volume could be raised to 16,400 tons if necessary.

Japan.—Nippon Yodo K. K. expects to turn out 500 to 600 tons a month of potassium sulphate as a byproduct of the manufacture of aluminum from alunite in the new aluminum plant.

MAGNESIUM AND ITS COMPOUNDS

By E. P. Partridge and A. E. Davis [1]

SUMMARY OUTLINE

The importance of magnesium in modern industry is due chiefly to two uses that present an interesting paradox. As a highly refractory material, magnesium oxide is employed extensively in open-hearth furnaces for the production of steel; as the lightest structural metal available commercially, magnesium is tending to replace steel for uses where light weight combined with strength is essential. Other important applications of magnesium compounds include the use of basic magnesium carbonate as a heat-insulating material, caustic calcined magnesite in floors and stucco, and magnesium chloride and magnesium sulphate in a variety of chemical industries.

Although the various products might be derived from any of the forms in which magnesium compounds occur naturally, the two industrial forms of magnesium oxide—dead-burned magnesite and caustic calcined magnesite—are obtained at present, as indicated by their names, from the mineral magnesite (magnesium carbonate). Dolomite (magnesium calcium carbonate) is dead-burned to produce a mixture of magnesium and calcium oxides for refractory purposes and also serves as the source of most of the basic magnesium carbonate used for heat insulation. Basic magnesium carbonate is also produced, however, from magnesite and from sea water and other brines. Natural brines are the raw material for magnesium sulphate and magnesium chloride. The latter compound, in turn, is used in the production of metallic magnesium.

This report discusses the domestic production and imports of crude magnesite and the calcined products derived therefrom, dolomite for specified uses in which it competes with magnesite, metallic magnesium, and magnesium salts.

MAGNESITE

The magnesite industry of the United States faces differing competitive situations with respect to its two chief products. Dead-burned magnesite for refractories must divide the domestic market

[1] Figures on imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

with magnesite imported from Europe and with dead-burned dolomite; caustic calcined magnesite must meet the increasing competition of other commodities developed for use as floor and wall materials. The fact that the domestic magnesite industry is located in California and Washington, far-removed from the centers of both the steel industry and population, places a considerable burden of transportation charges upon its products.

Salient statistics of the magnesite industry in the United States, 1930–34

	1930	1931	1932	1933	1934
Crude:					
Mined:					
Short tons	129,320	73,602	38,462	108,187	100,973
Value [1]	$1,033,130	$499,239	$283,304	$840,000	$730,630
Sold by producers:					
Short tons	1,120	1,325	575	1,576	1,588
Value	$14,410	$14,849	$5,474	$20,769	$18,393
Average per ton [2]	$12.87	$11.21	$9.52	$13.18	$11.58
Imports for consumption:					
Short tons	842	499	9	11	50
Value	$8,687	$5,415	$372	$200	$706
Apparent new supply ... short tons	1,962	1,824	584	1,587	1,638
Percent domestic	57.1	72.6	98.5	99.3	96.9
Caustic calcined:					
Sold by producers:					
Short tons	8,580	5,900	3,374	8,141	7,528
Value	$260,010	$180,997	$103,196	$249,115	$222,415
Average per ton [2]	$30.30	$30.68	$30.59	$30.60	$29.55
Imports for consumption:					
Short tons	3,911	2,891	1,777	1,850	1,553
Value	$66,523	$62,938	$29,351	$33,081	$36,031
Apparent new supply ... short tons	12,491	8,791	5,151	9,991	9,081
Percent domestic	68.7	67.1	65.5	81.5	82.9
Dead-burned:					
Sold by producers:					
Short tons	49,460	28,231	14,836	43,613	38,535
Value	$903,450	$545,253	$308,327	$774,875	$670,343
Average per ton [2]	$18.27	$19.31	$20.78	$17.77	$17.40
Imports for consumption:					
Short tons	41,417	10,349	7,613	23,509	22,921
Value	$624,713	$180,437	$109,340	$341,780	$368,014
Apparent new supply ... short tons	90,877	38,580	22,449	67,122	61,456
Percent domestic	54.4	73.2	66.1	65.0	62.7

[1] Partly estimated by the Bureau of Mines; most of the crude is processed by the mining companies, and very little enters the open market.
[2] Average receipts f. o. b. mine shipping point.

Domestic production.—The course of domestic production of crude magnesite for the 10-year period 1925–34 is indicated in figure 123, and the salient statistics of the magnesite industry for the 5-year period 1930–34 are given in the foregoing table. Figure 124 illustrates the trends with respect to the two chief products—dead-burned magnesite and caustic calcined magnesite—during the 10-year period 1925–34.

During 1934 the output of crude magnesite from 3 mines in California and 1 in Washington was 100,973 short tons, a decrease of 6.7 percent from the quantity of crude magnesite mined during 1933. Of this total, which was valued at $730,630, only 1,588 tons were sold crude. The value assigned to the total crude magnesite is determined by arbitrary valuations f. o. b. shipping points and is partly estimated.

Except for a very slight increase in the quantity of magnesite sold crude by producers, all sales in 1934 decreased in both quantity and value. Sales of calcined magnesite of domestic origin, as reported by producers, comprised 7,528 tons of caustic calcined valued at

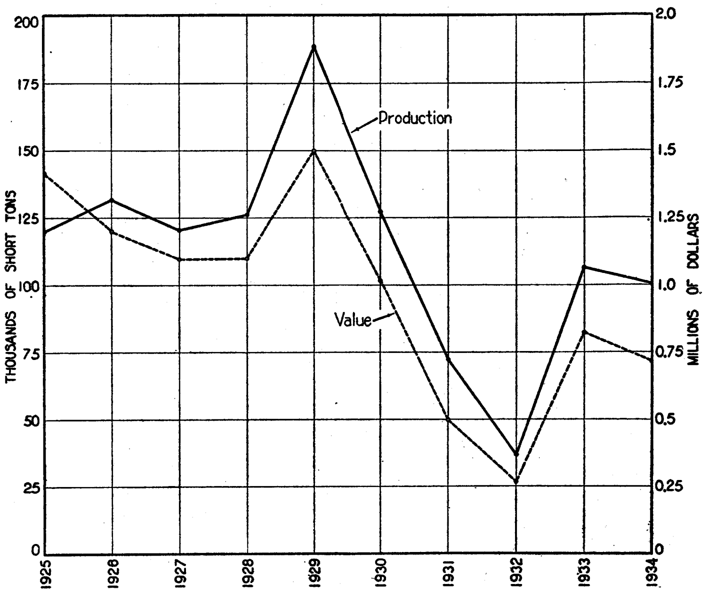

FIGURE 123.—Trends in production and value of crude magnesite, 1925–34. Imports of crude magnesite were less than 1,000 tons annually.

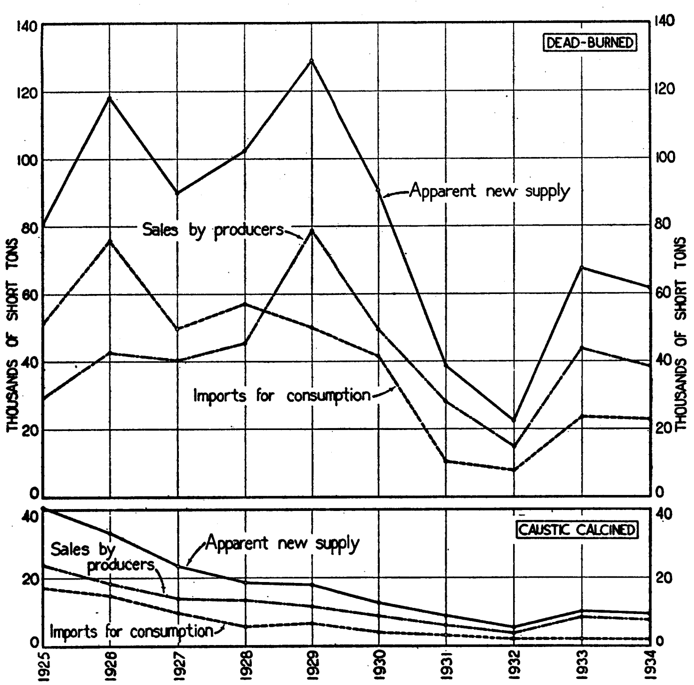

FIGURE 124.—Trends in sales by producers, imports for consumption, and apparent new supply of dead-burned and caustic calcined magnesite, 1925–34.

$222,415, a decrease of 7.5 percent in quantity and 10.7 percent in value from 1933, and 38,535 tons of dead-burned valued at $670,343, a drop of 11.6 percent in quantity and 13.5 percent in value. There was an increase in the quantity of magnesite sold for insulation, and in addition to sales of magnesite for refractory, plastic, insulating, and medicinal purposes some special calcined material was sold to the rubber trade.

California.—The California Chemical Co. operated in 1934 the properties (mines and plants) of the Sierra Magnesite Co., Ltd.—the Bald Eagle mine in Stanislaus County (above Ingomar) and the Western mine in Santa Clara County (above Livermore). Magnesite was also mined in California by Robert H. Smith (address, 1758 Mills Tower, San Francisco, Calif.), who operated the old Smith property in Stanislaus County, about 30 miles above Patterson; this mine formerly was operated by the California Magnesite Co.

Nevada.—The United States Brucite Corporation (address, Byington Building, Reno, Nev.) reported production of brucite (magnesium hydrate) in 1934 from its deposits near Luning, Nye County; the material was sold crude for plastic and medicinal purposes, the latter consuming the larger quantity.

Washington.—The Northwest Magnesite Co. (executive offices, Farmers Bank Building, Pittsburgh, Pa.) operated its Finch mine near Chewelah in Stevens County and reported that 2 of the 6 rotary kilns were in operation for 6 months and 3 for 2 months and that the entire operation was shut down for 4 months.

Prices.—Except for the two changes indicated below, prices quoted in trade journals remained constant throughout 1934 at the following values per short ton:

Dead-burned magnesite:	
F. o. b. Chewelah, Wash	$22.00
F. o. b. California mines:	
Standard	28.00
94 percent	65.00
90 percent	35.00
Caustic calcined magnesite:	
F. o. b. California mines:	
95 percent	40.00
85 percent	37.50

After June 21 standard dead-burned magnesite was quoted at $25 instead of $28, f. o. b. California mines. Before March 22 the grade of caustic calcined magnesite selling at $37.50 per ton was rated as 90 instead of 85 percent.

Imports.—Imports for consumption, as indicated in the preceding table of salient statistics and in figure 124, varied only slightly in tonnage from 1933 to 1934. In both years the quantity of crude magnesite received was negligible. The drop in the relatively small imports of caustic calcined magnesite was 16.1 percent, but the decrease in imports of the more important dead-burned magnesite was only 2.5 percent.

The fact that the basis for reporting imports by countries was changed by the Bureau of Foreign and Domestic Commerce from "general imports" in 1933 and earlier years to "imports for consumption" in 1934 must be borne in mind when 1934 is compa with earlier years in the following tables.

Magnesite imported into the United States, 1930–34, by countries, in short tons [1]

Country	1930	1931	1932	1933	1934
Austria	26,304	10,214	4,540	10,412	15,381
Belgium	32	54			
Canada	83	289	47	178	168
Czechoslovakia	19,080	5,635	2,393	3,064	5,548
Germany	264	95	55	3	3
Greece	976	779	77	17	146
India, British	2,563	1,305	1,127	921	579
Italy	5	14			
Netherlands	1,102	713	427	449	419
Norway				5	
Turkey in Asia and Europe				11	
U. S. S. R. (Russia in Europe)	714	4,714		2,007	1,800
United Kingdom	72	93	25	79	78
Yugoslavia			229	381	402
	51,195	23,905	8,920	17,527	24,524

[1] Data on total imports during 1934 are not strictly comparable with figures for previous years due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas total imports for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

As the 1933 figures for "general imports" and "imports for consumption" are identical for both crude and caustic calcined magnesite, comparison of the import statistics by countries for 1933 and 1934 is feasible. For dead-burned magnesite, however, such comparison is not possible as in 1933 general imports were 15,666 tons and imports for consumption were 23,509 tons. This difference indicates that a considerable quantity of dead-burned magnesite was withdrawn from bonded warehouses during 1933.

Magnesite imported into the United States, 1933–34, by countries and classes [1]

Country	Crude		Caustic calcined				Dead-burned and grain (not suitable for manufacture into oxychloride cements)	
			Lump		Ground			
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1933								
Austria							10,412	$144,359
Canada							178	12,893
Czechoslovakia							3,064	43,603
Germany					3	$318		
Greece					17	383		
India, British			921	$10,894				
Netherlands	11	$200			438	10,051		
Norway							5	298
Turkey in Asia and Europe			11	174				
U. S. S. R. (Russia in Europe)							2,007	32,908
United Kingdom			1	74	78	2,956		
Yugoslavia					381	8,231		
	11	200	933	11,142	917	21,939	15,666	234,061
1934								
Austria							15,381	232,079
Canada							168	12,602
Czechoslovakia							5,548	93,901
Germany					3	278		
Greece			55	1,418	89	1,760	2	31
India, British	28	287	529	8,071			22	287
Netherlands	22	419	23	669	374	10,151		
U. S. S. R. (Russia in Europe)							1,800	29,114
United Kingdom			11	542	67	2,956		
Yugoslavia					402	10,186		
	50	706	618	10,700	935	25,331	22,921	368,014

[1] Data on total imports in 1934 and 1933 are not strictly comparable due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in its system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

World production.—A general increase during 1933 in production of magnesite from established sources is indicated by the statistics in the following table. Unfortunately no figures are available by which to gage recent developments in Manchuria.

World production of magnesite, 1929–33, by countries, in metric tons [1]

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1929	1930	1931	1932	1933
Australia:					
New South Wales	9,097	8,794	3,480	5,199	9,512
Queensland				132	152
South Australia	137	37		117	205
Victoria	27	64	51	29	6
Austria	438,000	304,396	179,440	134,409	164,331
Canada [2]	39,216	25,073	24,345	2,833	(3)
China (Manchuria)	32,189	29,482	36,034	55,386	(3)
Czechoslovakia [4]	101,118	71,388	38,918	33,965	49,935
Greece	84,023	68,509	49,990	44,699	(3)
India, British	23,874	16,788	5,419	14,087	15,450
Italy	17,172	4,122	3,470	460	2,187
Norway	1,809	2,206	1,580	1,311	2,007
Southern Rhodesia				14	
Turkey	196	357	2,197	310	951
Union of South Africa	1,709	1,910	1,357	1,418	1,495
U. S. S. R. (Russia)	[5] 132,710	[5] 152,000	[5] 246,000	334,454	380,300
United States	170,241	117,317	66,770	34,892	98,145
Yugoslavia [6]	6,615	32,036	32,209	33,317	(3)

[1] Unless otherwise stated quantities in this table represent crude magnesite mined.
[2] Magnesitic dolomite.
[3] Data not available.
[4] Exports, less imports, of crude and sintered magnesite, the sintered being reduced to crude on the basis of 2.1 tons crude to 1 ton sintered.
[5] Year ended Sept. 30.
[6] Serbia only.

Austria.—Production of crude magnesite continued to increase in Austria during 1934, the total output of 258,382 metric tons exceeding that in 1933 by 57.2 percent; the Oesterreichisch-Amerikanische Magnesite Werke A.-G. supplied 112,540 metric tons and the Veitscher Magnesite Werke A.-G. 95,842 metric tons, the remainder coming from two smaller concerns. Only the two principal companies named produced dead-burned magnesite; their combined output of 64,726 metric tons in 1934 remained substantially unchanged from 1933, although their combined production of 28,780 tons of magnesite brick represented an increase of 13.4 percent. The total production of caustic calcined magnesite in Austria was 35,813 metric tons, an increase of 50.2 percent over that in 1933.

Exports of raw magnesite increased from 5,474 metric tons in 1933 to 19,432 tons in 1934; Germany was the chief market. There was a slight drop in exports of dead-burned magnesite, from 37,535 to 36,578 metric tons, due chiefly to cessation of orders from the United States during the last quarter of 1934; however, exports of magnesite bricks and plates increased from 24,920 to 26,276 metric tons, and there was an even greater increase in the export market for caustic calcined magnesite (located chiefly in Germany), which took 31,272 metric tons in 1934 compared with 19,108 tons in 1933.

Chosen.—The discovery of a deposit in Chosen estimated to contain 2 billion tons of high-grade magnesite led to the formation of the Japan Magnesium Metals Co. by Japanese and American capital.

Greece.—Virtually the entire production of Greek magnesite is exported. Exports during 1934 comprised 20,297 metric tons of crude magnesite to Italy, Great Britain, Netherlands, Germany, and France; 14,963 metric tons of calcined magnesite, chiefly to Netherlands, Great Britain, Germany, and France; and 9,393 metric tons of dead-burned magnesite, chiefly to Netherlands, Germany, Belgium, and Luxemburg.

Union of South Africa.—Total sales and shipments of magnesite in the Union of South Africa during 1934 were 1,667 metric tons.

Technology.—Steel-cased magnesite brick have been used for many years. Under furnace conditions the steel oxidizes and reacts with the magnesium oxide of adjacent bricks to produce a monolithic wall. These steel-cased brick previously have been manufactured by ramming magnesite into round or square steel forms. A new improvement is the use of a three-sided steel envelop which may be slipped over either burned or chemically bonded brick, thus allowing the use of high pressure during forming.

In addition to the extensive use of magnesite refractories in open-hearth furnaces, magnesite brick are employed in the hot zones of rotary kilns for burning lime, dolomite, and cement and in the roofs of reverberatory furnaces for the smelting of copper.

DOLOMITE

Dolomite (magnesium calcium carbonate), which occurs in many localities throughout the United States, is utilized on a large scale for a number of industrial applications in which it competes directly or indirectly with magnesite. Sales of dolomite and its products, 1930–34, for these uses have been segregated as far as possible in the following table.

Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1930–34

	1930	1931	1932	1933	1934 [1]
Dolomite for—					
Basic magnesium carbonate:					
Short tons	111,740	80,820	62,930	83,640	75,000
Value	$189,219	$122,525	$82,822	$99,630	$94,000
Carbon dioxide	(2)	(2)	(2)	(2)	(2)
Dead-burned dolomite or refractory stone:					
Short tons	453,350	268,500	72,240	196,540	249,000
Value	$356,025	$183,020	$45,186	$180,160	$238,000
Dolomitic lime for—					
Refractory (dead-burned dolomite):					
Short tons	351,740	243,769	135,733	261,812	309,000
Value	$3,045,082	$1,866,971	$1,055,399	$2,064,869	$2,585,000
Sulphite pulp:					
Short tons	38,400	32,000	24,000	25,000	24,000
Value	$295,000	$233,000	$148,000	$144,000	$156,000
Total (calculated as raw stone)......short tons	1,360,000	922,000	472,000	884,000	991,000

[1] Subject to revision.
[2] Bureau of Mines not at liberty to publish figures.

By far the most important use of both dolomite and magnesite is as a refractory in the dead-burned form. Figure 125 shows trends in the apparent supply of these two materials for the 10-year period 1925–34. The ratio of their respective tonnages averages about 6.5 tons of dead-burned dolomite to 1 ton of dead-burned magnesite, if the unusually high ratio of 10:1 for 1931 is excluded.

Although large quantities of dolomite are used in the production of basic magnesium carbonate for heat insulation, the latter material is also derived from magnesite and salt bitterns and in California, from sea water.

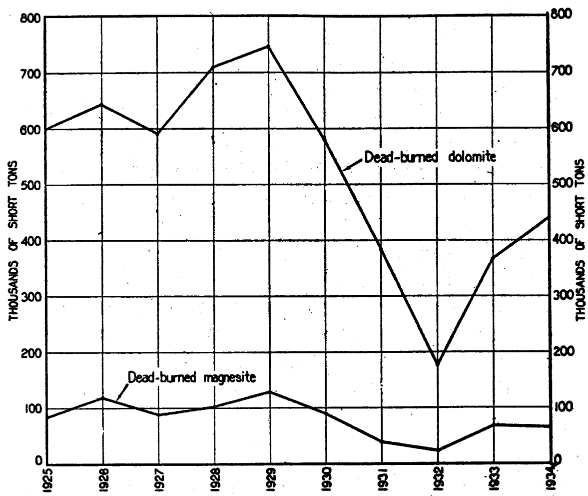

FIGURE 125.—Trends in apparent supply of dead-burned dolomite and dead-burned magnesite, 1925–34.

MAGNESIUM

The current trend toward reduction in weight of railroad cars, busses, trucks, trailers, airplanes, portable equipment, and machinery has developed keen competition between the light-weight metals—aluminum and magnesium—and special high-strength alloy steels. Magnesium is one third lighter than aluminum and has become increasingly competitive with it, although the volume of production still is comparatively small. An appreciable increase in magnesium production in 1934, coupled with a decrease in aluminum production, raised magnesium from 1.7 percent of the total light-metal output of the United States in 1933 to 5.4 percent in 1934.

Domestic production.—All the magnesium used in the United States, aside from negligibly small imports, is producted by the electrolysis of fused magnesium chloride at Midland, Mich., by The Dow Chemical Co. During 1934 the new magnesium ingot and stick sold or used by this company totaled 4,249,838 pounds, an increase of 196 percent over 1933; the average price for domestic consumption dropped from 28 to 26 cents per pound. This increase in production continues the steady growth of the magnesium industry since 1930.

New magnesium ingot and stick sold or used by the producer in the United States, 1930–34

Year	Pounds	Value	
		Total	Average price per pound [1]
1930	559,631	$268,864	$0.48
1931	580,463	199,633	.34
1932	791,699	228,653	.29
1933	1,434,893	377,181	.28
1934	4,249,838	(2)	.26

1 1930–32: Represents average of total sales; 1933–34: Represents average of sales for domestic consumption only.
2 Bureau of Mines not at liberty to publish figures.

The production of alloy ingot and of both structural and nonstructural magnesium products increased materially from 1933 to 1934,

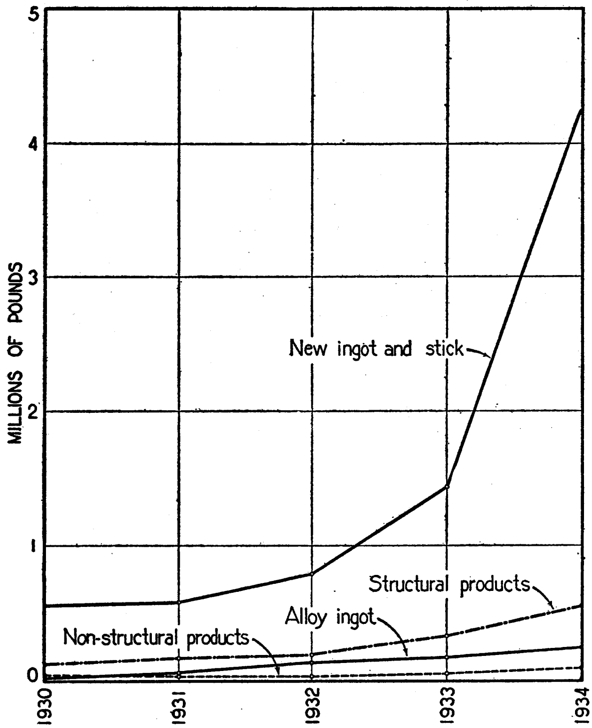

FIGURE 126.—Trends in production of magnesium ingot, magnesium-alloy ingot, and structural and nonstructural magnesium products, 1930–34.

although not as sharply as the production of new magnesium ingot. Figure 126 illustrates trends for the 5-year period 1930–34. Of the structural products, statistics for which are given in the following table, castings showed the greatest increase in volume from 1933 to 1934, due primarily to greater demands from the aircraft, portable tool, and office-equipment industries. In certain types of aircraft engines, magnesium sand castings comprise 65 percent of the total weight of castings. There has been a trend also toward the use of magnesium die castings for lightly stressed aircraft engine parts. Trucks and trailers continued as the more important outlets for plate, sheet, and structural shapes.

Magnesium products (other than ingot and stick magnesium) manufactured in the United States and sold or used by the companies manufacturing the products, 1930–34

Product	1930		1931		1932		1933		1934	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Alloy ingot	12,297	$7,800	65,314	$24,524	128,751	$48,563	165,729	$52,978	237,693	$69,696
Structural products:										
Castings	99,443	210,119	127,398	206,858	132,049	175,806	[1] 165,599	[1] 269,308	284,419	429,974
Sheet	1,348	2,857	9,433	8,221	17,796	10,940	57,750	29,408	93,591	49,236
Structural shapes, rods, and tubing [2]	2,994	3,511	[3] 194	[3] 294	19,154	10,309	45,275	24,263	94,935	48,726
Forgings	[4] 5,954	[4] 9,050	[3] 22,588	[3] 14,179	13,159	10,192	41,575	25,968	68,936	44,159
Other structural [2] [5]	[4] 4,725	[4] 7,188	4,357	2,025	6,964	6,489	[1] 15,507	[1] 11,507	4,137	1,374
Total structural products [6]	114,464	232,725	163,970	231,577	189,122	213,736	325,706	360,454	546,018	573,469
Nonstructural products:										
Wire and ribbon	7,898	19,817	2,906	9,026	4,650	10,806	8,464	14,684	10,348	16,989
Shavings [7]	501	501	768	445	1,863	827	15,500	7,771	55,469	27,643
Powder [7]	30,331	48,301	23,156	38,688	17,962	30,176	16,564	28,339	22,348	37,525
Other nonstructural [5]	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Total nonstructural products [6]	38,730	68,619	26,830	48,159	24,475	41,809	40,528	50,794	88,165	82,157
Grand total (exclusive of alloy ingot)	153,194	301,344	190,800	279,736	213,597	255,545	366,234	411,248	634,183	655,626

[1] An unknown quantity of die castings included under "Other structural."
[2] In 1930–33, inclusive, some structural shapes included under "Other structural"; separate figures not available.
[3] Some structural shapes, rods, and tubing included under "Forgings"; separate figures not available.
[4] Some forgings included under "Other structural"; separate figures not available.
[5] Small quantity of miscellaneous, unspecified, nonstructural products included under "Other structural"; separate figures not available.
[6] Small unspecified quantity of miscellaneous nonstructural products included under "Total structural products."
[7] Minor quantities of shavings included under "Powder"; separate figures not available.

Imports and exports.—Only a small quantity of magnesium has been imported in recent years. Imports for consumption in 1934 consisted of 661 pounds of powder valued at $962. The difference between the abrupt increase in new magnesium ingot sold or used by the manufacturer and the less-marked increase in quantity of fabricated products indicates that exports may have increased in 1934. (See fig. 126.) Exports of magnesium are not separately recorded.

Magnesium imported for consumption in the United States, 1933–34, by classes

Class	1933		1934	
	Pounds	Value	Pounds	Value
Powder (magnesium content)	560	$702	661	$962
Sheets, tubing, ribbons, wire, and other n. s. p. f. (magnesium content)	15	32		
	575	734	661	962

World production.—No accurate statistics are available, but it is estimated [2] that the world production of magnesium at the end of 1934 amounted to 30,000 or 35,000 tons annually. A large number of new concerns have entered the field, particularly in Japan and England. Because of the importance of magnesium to civil and military aviation, production facilities of all industrial countries apparently are being expanded.

Technology.—Progress in casting, forging, and heat treatment of magnesium alloys continued during 1934. Die castings, with their advantages of production economy, dimensional accuracy, and better finish, attained commercial status. Increased demand and stabilization of design enabled permanent molds to replace sand molds for the casting of some machine parts.

Development work has indicated that strong, light-weight, extruded sections can be manufactured from magnesium at costs per foot closely competitive with similar sections in aluminum alloys. Forgings of magnesium alloys still is in the experimental stage, and particular attention is being paid to the manufacture of aircraft propeller blades.

Through different types of heat treatment wide variations in tensile strength, ductility, hardness, and toughness may be produced in the cast magnesium alloy containing the following additions: Aluminum, 6 percent; manganese, 0.2 percent; and zinc, 3 percent. This material exhibits greater resistance to corrosion than other casting alloys.

Active research has been directed toward the study of forging sand castings, investigation of new alloy systems, determination of the mechanical properties of established alloys, protection of surfaces by coating and paints, and problems of welding and riveting. A revised series of tentative specifications covering magnesium-alloy ingot, castings, sheet, and forgings and a report on light metals and their alloys were published under the auspices of the American Society for Testing Materials.[3]

[2] Daily Metal Reporter, Feb. 12, 1935, p. 2.
[3] American Soc. for Testing Materials, Appendix to the report of Committee B-7 on Light Metals and Alloys—Cast and Wrought: Proc., vol. 34, pt. I, 1934, pp. 277-306.

MAGNESIUM SALTS

Domestic production.—The total production of natural magnesium salts (sulphate, chloride, carbonate, and hydroxide) in the United States in 1934 was 85,096,918 pounds valued at $1,266,325. Of this total, magnesium sulphate represented 60,517,075 pounds valued at $821,565 and was produced from natural brines by The Dow Chemical Co. at Midland, Mich., and the Texaco Salt Products Co. at West Tulsa, Okla. (address, Houston, Tex.), and from natural deposits of epsomite near Oroville, Okanogan County, Wash., by C. A. Kearney (address, 1208 Post Street, Seattle, Wash.), who leased the property of the Magnesia Co. (address, Portland, Oreg.). Commercial magnesium chloride made from natural brines and bittern waters was produced by the California Chemical Co. (address, 220 Bush Street, San Francisco, Calif.) and by The Dow Chemical Co. Magnesium carbonate was produced from sea water by a patented process by the Marine Chemicals Co., Ltd., South San Francisco, Calif., and also from sea water by the Plant Rubber & Asbestos Works (address, 537 Brannan Street, San Francisco, Calif.). Some magnesium hydroxide also was reported by the Marine Chemicals Co., Ltd., and is included in the totals for production of natural magnesium salts; separate figures are not available. Separate figures for magnesium chloride and magnesium carbonate may not be published, as there were less than three producers.

Imports.—Virtually all the magnesium chloride and magnesium sulphate imported into the United States originates in the German potash industry, where these salts are recovered as byproducts. The quantity of magnesium chloride imported has decreased continuously since 1926, but imports of magnesium sulphate, after a marked decrease from 1929 to 1930, increased annually from 1931 to 1933, inclusive, but decreased sharply in 1934.

Much of the magnesium carbonate imported comes from Great Britain.

Magnesium compounds imported for consumption in the United States, 1930–34

Year	Magnesium chloride (hydrated and anhydrous)		Magnesium sulphate (Epsom salts)		Calcined magnesia		Carbonate, precipitated		Magnesium silicofluoride or fluosilicate	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1930	2,000,081	$14,480	8,079,298	$54,646	392,160	$73,991	446,981	$24,989	67,524	$4,195
1931	1,320,071	19,660	9,465,098	61,718	420,026	78,649	570,805	32,310	103,551	4,938
1932	[1] 548,687	3,583	9,648,752	54,719	417,918	60,560	790,982	25,247	32,108	2,044
1933 [2]	[1] 408,563	2,997	10,006,980	60,517	404,137	69,479	624,602	26,655	11,977	572
1934	28,290	614	4,586,707	27,206	313,096	64,451	476,418	24,110	20,946	1,520

[1] No anhydrous reported.
[2] Also "manufactures of carbonate of magnesia" imported in 1933 as follows: 314 pounds valued at $74; none recorded 1930–32 and 1934.

MICA

By F. W. Horton and B. H. Stoddard

SUMMARY OUTLINE

Conditions in the domestic mica industry in 1934 were distinctly better than in 1933. There were substantial increases in both quantity and value of sales of all grades of uncut sheet mica, and the total value of sales of all classes of domestic mica increased more than 25 percent compared with 1933. Prices and consumption of sheet mica larger than punch and circle improved notably, and domestic stocks of radio-condenser and radio-tube-support mica were largely depleted at the close of the year. The demand for electrical mica for use in heating elements for flatirons, toasters, percolators, and similar equipment showed a moderate increase. Sales of domestic scrap decreased in quantity but increased slightly in value. The tonnage of dry-ground mica sold established a new record, but both the quantity and value of sales of wet-ground mica were slightly less than in 1933, although the price of wet-ground mica increased 15 percent. Consumption of splittings improved greatly, and in spite of increased imports there was a substantial decrease in stocks of splittings in the hands of consumers. Total imports and exports of mica increased 77 and 12 percent, respectively, in quantity and 61 and 60 percent, respectively, in value.

Although the United States is the world's largest consumer of mica it produces normally only 15 to 35 percent of its requirements of sheet mica larger than punch and circle and less than 5 percent of its requirements of splittings; however, it produces enough punch and scrap mica to satisfy nearly all domestic requirements. North Carolina and New Hampshire produced 50 and 28 percent, respectively, of the domestic output of sheet mica in 1934. The remainder came from Connecticut, Colorado, New Mexico, Georgia, Maine, and South Carolina, in order of total quantity sold. North Carolina, by far the largest producer of scrap mica, supplied nearly 62 percent of the domestic output during the year.

The following table summarizes the principal statistics of the mica industry in the United States from 1931 to 1934, inclusive.

Salient statistics of the mica industry in the United States, 1931–34

	1931	1932	1933	1934
Domestic mica sold or used by producers:				
Uncut sheet:				
Punch and circle:				
Pounds	757,647	258,512	253,243	425,156
Value	$33,317	$7,976	$10,199	$16,096
Average per pound	$0.04	$0.03	$0.04	$0.04
Larger than punch and circle:				
Pounds	205,306	80,485	111,297	158,372
Value	$78,513	$37,906	$42,980	$74,172
Average per pound	$0.38	$0.47	$0.39	$0.47
Total uncut sheet:				
Pounds	962,953	338,997	364,540	583,528
Value	$111,830	$45,882	$53,179	$90,268
Average per pound	$0.12	$0.14	$0.15	$0.15
Scrap:				
Short tons	6,621	7,040	8,751	7,719
Value	$99,415	$83,777	$98,159	$99,791
Average per ton	$15.02	$11.90	$11.22	$12.93
Total sheet and scrap:				
Short tons	7,102	7,209	8,933	8,011
Value	$211,245	$129,659	$151,338	$190,059
Ground:				
Dry-ground: [1]				
Pounds	10,724,952	10,505,884	12,877,593	13,647,975
Value	$168,783	$126,714	$135,178	$156,046
Average per pound	$0.016	$0.012	$0.010	$0.011
Wet-ground:				
Pounds	4,888,100	4,903,962	6,783,412	5,445,993
Value	$267,653	$184,126	$263,503	$247,284
Average per pound	$0.055	$0.038	$0.39	$0.045
Total ground:				
Pounds	15,613,052	15,409,846	19,661,005	19,093,968
Value	$436,436	$310,840	$398,681	$403,330
Consumption of splittings: [2]				
Pounds	2,039,590	898,249	1,428,329	1,763,035
Value	$763,870	$268,285	$343,161	$490,148
Imports for consumption:				
Unmanufactured:				
Pounds	4,549,122	2,970,742	3,853,906	7,688,458
Value	$132,865	$78,496	$178,953	$247,408
Manufactured:				
Cut:				
Pounds	16,707	23,097	39,787	68,619
Value	$19,774	$16,824	$25,609	$64,498
Splittings:				
Pounds	1,527,656	944,628	1,343,329	2,145,950
Value	$463,928	$184,920	$255,401	$442,949
Built-up:				
Pounds	1,787	12,956	15,244	7,637
Value	$3,483	$6,871	$10,795	$5,651
Ground:				
Pounds	1,200	111,771	537,776	318,464
Value	$36	$383	$1,388	$907
All other manufactured:				
Pounds	1,947	1,287	3,441	1,898
Value	$698	$173	$1,611	$1,209
Total manufactured:				
Pounds	1,549,297	1,093,739	1,939,577	2,542,568
Value	$487,919	$209,171	$294,804	$515,214
Total imports:				
Pounds	6,098,419	4,064,481	5,793,483	10,231,026
Value	$620,784	$287,667	$473,757	$762,622
Exports (all classes of mica):				
Pounds	5,239,007	3,098,737	3,125,873	3,502,498
Value	$258,135	$132,755	$117,863	$188,525

[1] Includes fine unground mica recovered in washing kaolin but not mica recovered by milling mica schist.
[2] Exclusive of a nominal quantity of splittings produced in South America and the United States.

PRODUCTION

The total quantity of sheet and scrap mica sold or used by producers in the United States in 1934 was 8,011 short tons valued at $190,059 compared with 8,933 tons valued at $151,338 in 1933. The total for 1934 comprised 583,528 pounds of uncut sheet valued at $90,268 and 7,719 short tons of scrap valued at $99,791. Of this amount North Carolina produced 293,381 pounds of sheet valued at $38,674 and 4,757 tons of scrap valued at $59,496 and New Hampshire 161,430 pounds of sheet valued at $14,423 and 537 tons of scrap valued at $9,529. Compared with 1933 total sales of unmanufactured domestic mica in 1934 decreased 10.3 percent in quantity but increased 25.6 percent in value.

Uncut sheet mica.—Total sales of uncut sheet mica in 1934 increased 60.1 percent in quantity and 69.7 percent in value compared with 1933. Punch and circle mica sold by producers totaled 425,156 pounds valued at $16,096—an increase of 67.9 percent in weight and 57.8 percent in value over sales in the previous year. Sales of sheet larger than punch and circle aggregated 158,372 pounds valued at $74,172—a gain of 42.3 percent in quantity and 72.6 percent in value over those in 1933.

Scrap mica.—The tonnage of scrap mica sold by producers in 1934 decreased 11.8 percent, but its value increased 1.7 percent compared with 1933. The figures for scrap mica include a considerable tonnage of fine mica recovered as a byproduct in washing kaolin in North Carolina but do not include mica obtained by grinding mica schist.

The production of scrap mica was, as usual, the mainstay of the domestic mica-mining industry, and its value in 1934 constituted 52.5 percent of the total value of the domestic production of all classes of unmanufactured mica.

The following tables show the quantity and value of the various classes of domestic mica sold or used by producers in the United States and in the two principal producing States—New Hampshire and North Carolina—from 1930 to 1934.

Domestic mica sold or used by producers in the United States, 1930–34

Year	Sheet mica						Scrap mica		Total	
	Uncut punch and circle mica		Uncut mica larger than punch and circle		Total uncut sheet mica					
	Pounds	Value	Pounds	Value	Pounds	Value	Short tons	Value	Short tons	Value
1930	1,253,782	$61,230	211,703	$116,077	1,465,485	$177,307	6,732	$109,100	7,465	$286,407
1931	757,647	33,317	205,306	78,513	962,953	111,830	6,621	99,415	7,102	211,245
1932	258,512	7,976	80,485	37,906	338,997	45,882	7,040	83,777	7,209	129,659
1933	253,243	10,199	111,297	42,980	364,540	53,179	8,751	98,159	8,933	151,338
1934	425,156	16,096	158,372	74,172	583,528	90,268	7,719	99,791	8,011	190,059

Mica sold or used by producers in chief producing States, 1930–34

State and year	Sheet mica						Scrap mica		Total	
	Uncut punch and circle mica		Uncut mica larger than punch and circle		Total uncut sheet mica					
	Pounds	Value	Pounds	Value	Pounds	Value	Short tons	Value	Short tons	Value
New Hampshire:										
1930	616,204	$29,275	56,860	$24,029	673,064	$53,304	449	$8,743	786	$62,047
1931	349,168	17,342	91,996	19,026	441,164	36,368	295	5,465	516	41,833
1932	121,487	3,607	24,527	14,371	146,014	17,978	344	5,585	417	23,563
1933	117,333	3,940	50,131	18,068	167,464	22,008	532	9,563	616	31,571
1934	118,508	3,788	42,922	10,635	161,430	14,423	537	9,529	618	23,952
North Carolina:										
1930	610,216	30,567	138,858	81,884	749,074	112,451	4,744	75,400	5,119	187,851
1931	310,366	12,894	79,060	38,763	389,426	51,657	5,312	79,601	5,507	131,258
1932	85,803	2,906	41,893	15,416	127,696	18,322	4,837	56,842	4,901	75,164
1933	117,826	5,322	44,846	15,785	162,672	21,107	6,918	74,711	6,999	95,818
1934	225,967	9,080	67,414	29,594	293,381	38,674	4,757	59,496	4,904	98,170

Ground mica.—The quantity of ground mica sold by domestic producers in 1934 was 19,093,068 pounds valued at $403,330, a decrease of 2.9 percent in weight but an increase of 1.2 percent in value compared with 1933 when a new high record was established for the quantity sold. The figures for dry-ground mica include sales of byproduct mica recovered in washing kaolin by the Harris Clay Co. and the General Mica Co. in Mitchell County, N. C., but do not include fine mica obtained from ground muscovite schists. The maintenance of sales of ground mica at near record level is indicative of its increased use in the roofing, wall-paper, and rubber trades which provide its chief markets. Following is a list of companies that ground mica in 1934; 7 used dry-grinding and 6 wet-grinding processes.

	Process
Asheville Mica Co., Biltmore, N. C	Dry.
Concord Mica Co., Concord, N. H	Wet.
English-Richmond Mica Corporation, 323 South Ninth Street, Richmond, Va	Do.
Franklin Mineral Products Co., Franklin, N. C	Do.
General Mica Co., Inc., Pueblo, Colo	Dry.
Marion Mica Mills, Marion, N. C	Wet.
Newdale Mica Co., Micaville, N. C	Dry.
Southern Mica Co., Franklin, N. C	Do.
Standard Oil Co., 910 South Michigan Avenue, Chicago, Ill	Do.
U. S. Mica Manufacturing Co., 1521–1527 Circle Avenue, Forest Park, Ill	Do.
D. T. Vance, Plumtree, N. C	Wet.
Vance-Barrett, Inc., Plumtree, N. C	Do.
Western Elaterite Roofing Co., 841 Equitable Building, Denver, Colo	Dry.

The following tables show the quantity and value of ground mica sold by producers in the United States, according to method of grinding, from 1930 to 1934 and the distribution of the 1934 sales to various industries.

Ground mica [1] sold by producers in the United States, 1930–34, by methods of grinding

Year	Dry ground [1]		Wet ground		Total	
	Pounds	Value	Pounds	Value	Pounds	Value
1930	11,912,232	$190,635	3,149,545	$161,623	15,061,777	$352,258
1931	10,724,952	168,783	4,888,100	267,653	15,613,052	436,436
1932	10,505,884	126,714	4,903,962	184,126	15,409,846	310,840
1933	12,877,593	135,178	6,783,412	263,503	19,661,005	398,681
1934	13,647,975	156,046	5,445,993	247,284	19,093,968	403,330

[1] Includes sales of mica suitable for roofing material without grinding.

Ground mica sold to various industries in the United States in 1934

Industry	Quantity		Value
	Pounds	Percent of total	
Roofing [1]	13,188,750	69	$149,082
Wall paper	3,554,900	19	170,187
Rubber	1,715,350	9	68,631
Miscellaneous [2]	634,968	3	15,430
	19,093,968	100	403,330

[1] Includes sales of mica suitable for roofing material without grinding.
[2] Figures cover mica used for molded electric insulation, paint manufacture, surfacing on asphalt shingles, Christmas-tree snow, manufacture of axle greases and oil, annealing, concrete and foundry facing, pipe-line enamel, plastic specialties, and other purposes.

CONSUMPTION AND STOCKS OF MICA SPLITTINGS

Domestic consumption of splittings in 1934 was about 1,767,000 pounds valued at approximately $491,000 compared with about 1,428,000 pounds valued at $343,000 in 1933, an increase of 24 percent in quantity and 43 percent in value. Virtually all the splittings used in the United States are produced by hand and are imported from India, Madagascar, and Canada. Most of them are Indian muscovite grades 5, 5½, and 6. Approximately 81 percent of the domestic consumption of splittings in 1934 came from India. Madagascar and Canada are the sole sources of commercial amber mica or phlogopite and supply nearly all of the amber splittings used in the United States.

The accompanying tables show the quantity, value, and source of the mica splittings consumed in the United States from 1930 to 1934 and of stocks in hands of consumers on December 31, 1933 and 1934. Stocks at the end of 1934 decreased 18.2 percent in quantity and 12.6 percent in value compared with those at the close of 1933.

Mica splittings consumed in the United States, 1930–34, by sources, as reported by consumers [1]

Year	India		Canada		Madagascar	
	Pounds	Value	Pounds	Value	Pounds	Value
1930	2,450,642	$1,064,160	422,221	$125,330	163,017	$75,647
1931	1,713,954	648,169	163,091	52,258	162,545	63,443
1932	666,911	193,309	73,810	13,655	157,528	61,321
1933	1,088,796	233,075	84,494	24,412	255,039	85,674
1934	1,423,635	350,561	94,422	37,903	244,978	101,684

[1] Exclusive of a nominal quantity of splittings produced in South America and the United States.

Stocks of mica splittings in hands of consumers, Dec. 31, 1933–34

Source	1933		1934	
	Pounds	Value	Pounds	Value
Canada	185,192	$64,617	200,018	$80,976
India	1,178,644	312,589	924,028	240,792
Madagascar	264,716	85,586	208,354	82,809
	1,628,552	462,792	1,332,400	404,577

Figure 127 shows the quantity and value of mica splittings and sheet mica larger than punch and circle consumed in the United States from

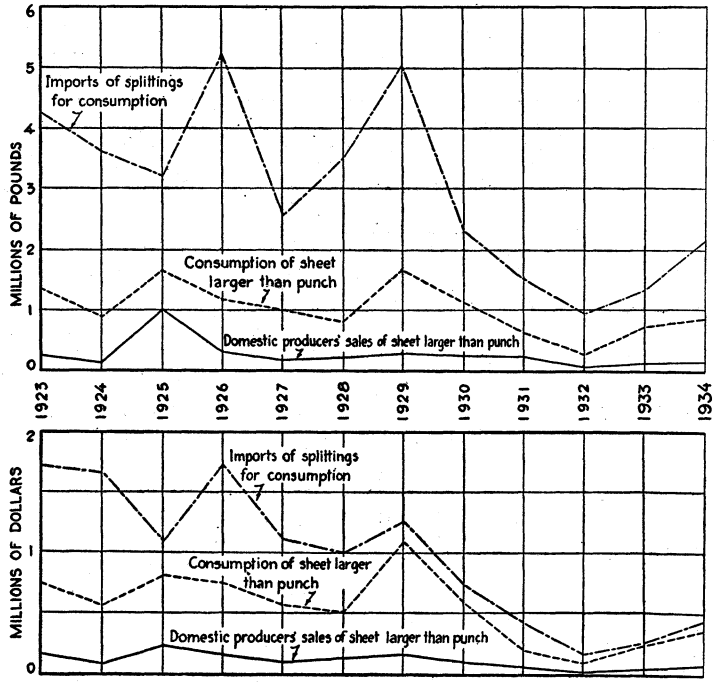

FIGURE 127.—Comparison of consumption of mica splittings and consumption and production of sheet mica larger than punch and circle in the United States, 1923–34.

1923 to 1934 and compares the marketed production of domestic sheet mica larger than punch with the total consumption of these sizes. The graph shows clearly the major importance of mica splittings in the domestic market and the small proportion of domestic requirements of sheet larger than punch supplied by domestic production. The graph shows further that during the period covered the quantity and value of splittings, virtually all of which are imported, have in every year greatly exceeded those of domestic and imported sheet combined and have been 3 to 25 times those of domestic sheet.

MARKET AND PRICES

Domestic sheet mica.—Demand for all classes of sheet mica improved in 1934. The average price of punch and circle mica was $0.04 per pound, as in 1933, but the average price paid domestic producers for larger sizes of sheet advanced to $0.47 per pound compared with $0.39 in the previous year, an increase of 20.5 percent.

The accompanying table shows the range of prices for domestic, rough-trimmed, uncut sheet mica as reported by producers in 1934.

Range of prices per pound paid for domestic, rough-trimmed, uncut sheet mica in 1934

Size	Clear	Stained	Size	Clear	Stained
Punch	$0.03-$0.06	$0.02-$0.04	3 by 4 inches	$0.80-$1.50	$0.50-$1.00
1½ by 2 inches	.15- .30	.08- .20	3 by 5 inches	1.00- 1.90	.75- 1.60
2 by 2 inches	.20- .55	.12½-.25	4 by 6 inches	1.25- 3.00	1.20- 1.75
2 by 3 inches	.30- .90	.20- .40	6 by 8 inches	1.50- 4.00	1.25- 3.00
3 by 3 inches	.50- 1.25	.35- .60			

Foreign sheet mica.—Consumption of smaller grades (Nos. 5½ and 6) of fair-stained and good-stained Indian mica used for condenser films and radio-tube supports increased sharply in 1934, and in the last quarter of the year prices of these grades advanced notably, particularly that of No. 6 condenser mica. The mica bazaars in India sold out stocks of Nos. 5, 5½, and 6, fair-stained block mica, and at the close of the year there was a shortage of condenser mica with the price of this material about 50 percent higher than in 1933. The price of No. 6 good-stained mica suitable for tube supports advanced about 25 percent during the year on increased demand in both the United States and Europe.

Prices for electrical mica were consistently higher in London than in New York, and in many instances it was possible to buy mica in New York at lower prices than those ruling abroad. As a consequence part of the supplies from India and Brazil that formerly came to New York were directed to London. Prices for sheet phlogopite remained practically the same as in 1933.

The following table shows the average quoted prices of various grades of domestic and Indian mica in New York in 1934.

Approximate average quoted prices, per pound of uncut sheet mica in New York in 1934

Domestic		Indian (duty paid)					
Size (inches)	Nos. 1 and 2 stove mica	Size (number)	Clear and slightly stained	Fair stained	Good stained	Stained	Black spotted
1½ by 2	$0.26	6	$0.62	$0.57	$0.39		
2 by 2	.41	5	1.84	1.54	1.39	$0.54	$0.34
2 by 3	.66	4	2.44	1.69	1.54	1.09	.64
3 by 3	.87	3	3.04	2.29	1.99	1.62	.99
3 by 4	1.12	2	3.64	2.74	2.59	2.14	1.47
3 by 5	1.46	1	4.24	3.64	3.12	2.89	1.99
4 by 6	2.61	A-1	6.94	5.44	5.29	4.09	2.14
6 by 8		Special	8.28	6.79	6.04	5.29	2.22

Mica splittings.—World consumption of Indian splittings in 1934 increased greatly over 1933, but the increased demand was not sufficient to absorb completely the large supply of splitting stock which had accumulated since 1930. Consequently, prices for splittings did not rise with the increased demand during the year; in fact, the price of some grades decreased due to the anxiety of weak holders to liquidate stocks. However, supplies of good splitting mica in India are becoming exhausted. Stocks of inferior splitting material, however, are not being absorbed to the same extent as those of better grade. At the end of 1934 the market for splittings was firm.

Average prices per pound of Indian splittings, duty paid, in New York were as follows: No. 4, book-packed, $0.93; loose, $0.75. No. 5, book-packed, $0.83; loose, $0.45. No. 5½, book-packed, $0.75; loose, $0.30. No. 6, book-packed, $0.50; first-quality loose, $0.23; second-quality loose, $0.175; third-quality loose, $0.13; cheap loose, $0.10. Prices of amber splittings remained firm due to restricted supply and a somewhat increased demand. The average prices per pound of Madagascan amber splittings, duty paid, in New York were as follows: No. 4 amber, $0.65; No. 5, $0.45; No. 6, $0.40. The average prices per pound of splittings consumed in the United States in 1934 were as follows: Indian splittings, $0.246; Canadian splittings, $0.401; and Madagascan splittings, $0.415.

Scrap mica.—The average price of domestic scrap in 1934 was $12.93 per short ton, the highest since 1931 and $1.71 per ton more than in 1933.

Ground mica.—The average price of dry-ground mica increased slightly to $0.011 per pound compared with $0.01 in 1933. The demand for this grade was excellent, and the quantity sold established a new record. The average price of the wet-ground product advanced to $0.045 per pound compared with $0.039 in 1933.

FOREIGN TRADE [1]

Imports.—Advances in domestic prices of mica during 1934 encouraged large imports, which totaled 10,231,026 pounds valued at $762,622, increases of 76.6 percent in quantity and 61 percent in value over 1933. In unmanufactured mica the quantity increased 3,834,552 pounds (99.5 percent) and the value $68,455 (38.3 percent). Imports of splittings increased 802,621 pounds (59.7 percent) and their value increased $187,548 (73.4 percent).

The accompanying table shows the classification, quantity, and value of mica imported for consumption in the United States in 1934 and the countries from which it was last shipped.

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Mica imported for consumption in the United States in 1934, by kinds and by countries [1]

Country	Unmanufactured										Manufactured											
					Other						Films and splittings											
											Not cut or stamped to dimensions											
	Waste and scrap, valued at not more than 5 cents per pound (duty 25 percent)		Untrimmed phlogopite mica from which no rectangular piece exceeding 1 inch by 2 inches in size may be cut (duty 15 percent)		Valued at not above 15 cents per pound (duty 4 cents per pound)		Valued above 15 cents per pound (duty 4 cents per pound+25 percent)		Cut mica (duty 40 percent)		Not above 12 ten-thousandths of an inch in thickness (duty 25 percent)		Over 12 ten-thousandths of an inch in thickness (duty 40 percent)		Cut or stamped to dimensions (duty 45 percent)		Mica plates and built-up mica (duty 40 percent)		All manufactures of which mica is the component material of chief value (duty 40 percent)		Mica ground or pulverized (duty 20 percent)	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Africa:																						
British:																						
East							1,943	$636			1,805	$549										
Union of South	450,130	$1,620			292	$34	133	53														
Other British South					608	78																
Madagascar							2,732	1,798			130,683	30,839										
Argentina					4,899	675	15,587	6,155														
Bolivia							555	483														
Brazil					22,765	2,247	36,082	13,056														
Canada	1,720,670	7,803	26,391	$2,396	1,889	257	10,084	6,016	1,085	$683	84,756	38,495	9,520	$2,119			100	$100	9	$99	4,000	$50
Czechoslovakia					979	133																
France					441	53	5,815	3,367	4	12	129,881	35,012							200	110		
Germany							255	120	18,158	18,883							1,551	1,771				
Guatemala							279	276														
India, British	3,224,756	14,138			87,000	11,140	355,344	117,923	48,161	42,820	1,602,597	256,116	145,834	67,037	1,367	$1,570	103	252				
Italy							180	62														
U. S. S. R. (Russia)	1,614,323	4,313																			314,464	857
United Kingdom					13,053	1,757	91,273	50,819	1,211	2,100	37,258	10,458	2,156	731	93	23	5,883	3,528	1,689	1,000		
	7,009,879	27,874	26,391	2,396	131,926	16,374	520,262	200,764	68,619	64,498	1,986,980	371,469	157,510	69,887	1,460	1,593	7,637	5,651	1,898	1,209	318,464	907

[1] Data on total imports during 1934 may not be strictly comparable with figures published in previous reports of this series due to the change made by the Bureau of Foreign and Domestic Commerce, beginning January 1934, in the system of reporting imports. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

Exports.—Exports of mica in 1934 amounted to 3,502,498 pounds valued at $188,525, an increase of 376,625 pounds (12 percent) in quantity and of $70,662 (60 percent) in value compared with 1933.

The accompanying table shows the quantity, value, and destination of the mica exported from the United States in 1934. As mica is not classified in export schedules, it is impossible to state what kinds are exported.

Mica and manufactures of mica exported from the United States in 1934, by countries

Country	Pounds	Value
North America:		
Canada	1,973,812	$89,816
Central America:		
British Honduras	12	5
Guatemala	85	213
Honduras	2	3
Nicaragua	7	20
Panama	152	231
Salvador	28	85
Mexico	8,000	1,864
Newfoundland and Labrador	122	89
West Indies:		
British:		
Jamaica	29	59
Trinidad and Tobago	35	50
Cuba	951	871
Netherland	11	203
South America:		
Argentina	7,872	564
Brazil	1,341	1,792
Chile	1,281	1,633
Colombia	80	119
Ecuador	19	62
Peru	33	85
Uruguay	68	247
Venezuela	53	41
Europe:		
Belgium	272,347	$16,650
Denmark	2,000	123
France	77,889	4,182
Germany	269,928	13,808
Hungary	1,000	510
Italy	3,153	656
Netherlands	26,010	1,297
Spain	2,244	185
United Kingdom	845,840	49,581
Asia:		
China	2,010	516
East India (British):		
India	1,156	1,770
Malaya	7	22
Palestine	855	179
Philippine Islands	75	339
Other Asia	50	181
Africa:		
Mozambique	9	25
Union of South Africa	55	137
Oceania:		
Australia	3,877	312
	3,502,498	188,525

World production of mica, 1930–34, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1930	1931	1932	1933	1934
North America:					
Canada (sales)	1,061	1,214	280	857	905
United States (sold or used by producers)	6,772	6,443	6,540	8,104	7,267
South America:					
Argentina [1]	100	51	55	75	(2)
Bolivia [3]	15	1	8	(2)	(2)
Brazil [3]	52	54	42	23	(2)
Colombia	15	(2)	(2)	(2)	(2)
Europe:					
Italy	----------	12	9	3	(2)
Norway [3]	53	48	103	105	(2)
Sweden	73	65	61	68	(2)
Asia:					
Ceylon	----------	2	2	(4)	(2)
Chosen	29	18	20	23	(2)
India, British [5]	4,212	2,691	2,389	2,932	(2)
Africa:					
Madagascar [6]	348	235	140	173	(2)
Rhodesia:					
Northern	4	1	----------	2	(2)
Southern	164	67	13	4	2
Tanganyika Territory	21	9	12	11	(2)
Union of South Africa (Transvaal) (sales)	501	477	250	549	278
Oceania:					
Australia:					
Northern Territory (Central Australia)	26	28	30	43	(2)
South Australia	----------	2	----------	(2)	(2)

[1] Rail and river shipments.
[2] Data not available.
[3] Exports.
[4] Less than 1 ton.
[5] Exports. The figures for output are incomplete, and a more accurate idea of the size of the industry is to be obtained from the export figures. (Rec. Geol. Surv. of India, vol. 59, pt. 3, p. 273 Calcutta, 1926.) Output is reported as follows: 1930, 2,679 tons; 1931, 1,979 tons; 1932, 1,662 tons; 1933, 2,087 tons.
[6] Exports reported as follows: 1930, 397 tons; 1931, 120 tons; 1932, 130 tons; 1933, 246 tons.

NATURAL SODIUM COMPOUNDS AND BORON MINERALS

By A. T. Coons

SUMMARY OUTLINE

The natural sodium compounds industry, with an output of 347,375 short tons in 1934, continued the steady growth that has been its outstanding feature since 1920 when only 42,683 tons were produced. Production reached 297,440 tons in 1930 and declined only 2.6 percent in 1931 and 9.4 percent in 1932. In 1933 the output increased 2.6 percent over the former peak of 1930 and 13 percent over 1932; in 1934 it advanced to a new high, demonstrating the strength of the market for natural sodium compounds irrespective of general adverse business conditions.

Although production has been maintained on a relatively stable plane, price declines have been unavoidable. Returns to producers were particularly low in 1932 and 1933 but increased in 1934.

The output of sodium compounds (not including common salt) from natural salines and brines in the United States in 1934 was 347,375 short tons valued at $6,222,352, an increase of 14 percent in quantity and 35 percent in value compared with the output in 1933 of 305,047 tons valued at $4,599,912. These totals cover the output of sodium carbonate (soda ash and trona), sodium bicarbonate, sodium sulphate (salt cake and Glauber's salt), and sodium borate (borax and kernite).

The output of carbonates, which declined 39 percent from 1930 to 1932 and then increased 27 percent in 1933, advanced an additional 25 percent in 1934 but did not equal the peak of 102,930 tons in 1929. The output of sulphates, which varied only a few hundred tons from 1930 to 1932, increased 45 percent in 1933 but declined 64 percent in 1934. The output of borates has increased each year since 1926, reaching a peak of 242,400 tons in 1934, or 29 percent more than in 1933.

Figure 128 gives the quantity and value of natural sodium compounds produced in the United States, 1925–34.

Production of natural sodium compounds (exclusive of common salt), 1930–34, is given in the following table.

4744—35——76

Natural sodium compounds sold or used by producers in the United States, 1930–34

Year	Carbonates [1]		Sulphates [2]		Borates [3]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	90, 300	$1, 585, 756	32, 630	$206, 323	174, 510	$5, 105, 425	297, 440	$6, 897, 504
1931	78, 530	1, 223, 544	32, 510	198, 132	178, 550	4, 931, 295	289, 590	6, 352, 971
1932	55, 377	888, 052	32, 204	210, 342	181, 915	3, 023, 844	269, 496	4, 122, 238
1933	70, 461	918, 295	46, 539	245, 240	188, 047	3, 436, 377	305, 047	4, 599, 912
1934	88, 325	1, 254, 113	16, 650	148, 225	242, 400	4, 820, 014	347, 375	6, 222, 352

[1] Soda ash, bicarbonate, and trona; in 1930 includes sal soda also.
[2] Salt cake and Glauber's salt.
[3] 1930: Borax and kernite; 1931–34: Borax, kernite, and boric acid (calculated as borax).

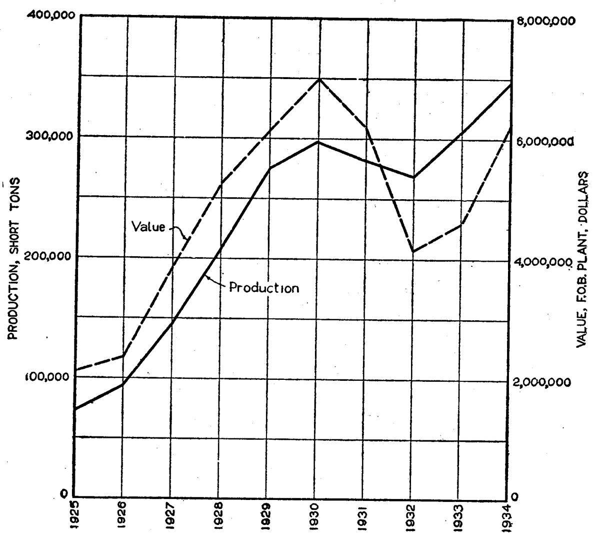

FIGURE 128.—Quantity and value of natural sodium compounds produced in the United States, 1925–34.

Boron minerals.—The output of boron minerals in 1934, as reported to the Bureau of Mines by producers, amounted to 242,500 short tons valued at $4,822,014, an increase of 29 percent in quantity and 40 percent in value compared with 1933.

Boron minerals [1] sold or used by producers in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	177, 360	$5, 351, 999	1933	188, 047	$3, 436, 377
1931	178, 550	4, 931, 295	1934	242, 500	4, 822, 014
1932	181, 915	3, 023, 844			

[1] 1930: Borax, kernite, colemanite, and boric acid; 1931–33: Borax, kernite, and boric acid (calculated as borax); 1934: Borax, kernite, boric acid (calculated as borax), and colemanite.

In 1934 a small quantity of mixed colemanite and ulexite is included with the sodium borates (borax and kernite) under boron minerals. Before 1927 the source of all the borax except that made at Searles Lake and Owens Lake was colemanite (calcium borate) mined in

California and Nevada. In 1927 kernite mined in Kern County, Calif., replaced colemanite, production of which virtually ceased after 1927, although small shipments were made through 1930.

Review of operations.—In 1934 most of the material included in the sales of sodium carbonate was soda ash—normal sodium carbonate (Na_2CO_3)—produced in California from the waters of Owens Lake in Inyo County, by the Natural Soda Products Co. at Keeler and the Pacific Alkali Co. at Bartlett, and from the waters of Searles Lake in San Bernardino County, by the American Potash & Chemical Co. at Trona and the West End Chemical Co. at Westend. Sodium bicarbonate ($NaHCO_3$) and trona, a mixture of soda ash and bicarbonate, were produced by the Natural Soda Products Co.

Sodium sulphate, as salt cake (Na_2SO_4), was produced at Trona on Searles Lake, San Bernardino County, Calif., by the American Potash & Chemical Co.; near Mina, Mineral County, Nev., by the Rhodes Alkali & Chemical Corporation; and near Monahans, Ward County, Tex., by the Ozark Chemical Co. of Tulsa, Okla. A small quantity for medicinal purposes was produced by the Spokanogan Chemical Co. at Okanogan, Okanogan County, Wash. The sodium sulphate deposits at Camp Verde, Yavapai County, Ariz., operated in 1933 by the Arizona Chemical Co., and at Wabuska, Lyon County, Nev., owned by the American Sodium Co., were not operated in 1934 and no material was shipped. Hydrated sodium sulphate ($Na_2SO_4.10H_2O$) (Glauber's salt) was produced near Casper, Natrona County, Wyo., by W. E. Pratt. The Iowa Soda Products Co. mined Glauber's salt near Rawlins, Carbon County, Wyo., and shipped it to Council Bluffs, Iowa, for refining. There was a small output of sodium sulphate (salt cake and Glauber's salt) near Twentynine Palms, San Bernardino County, Calif., by the Chemical Mines Co., but the work was experimental and none of the product was shipped. The Salt Lake Sodium Products Co. (Great Salt Lake Chemical Co., owner), Salt Lake City, Utah, erected a plant in 1933 for the production of sodium sulphate near Saltair on Great Salt Lake but manufactured none in 1934. More complete information on sodium sulphate is contained in a report by Tyler.[1]

The sodium borate produced in 1934 includes borax ($Na_2B_4O_7.10H_2O$) obtained in California from Searles Lake brines in San Bernardino County, by the American Potash & Chemical Co. at Trona and the West End Chemical Co. at Westend, and from Owens Lake brines in Inyo County, by the Pacific Alkali Co. at Bartlett. Sodium borate, as kernite ($Na_2B_4O_7.4H_2O$), was produced in Kern County, Calif., by the Pacific Coast Borax Co. from the Baker deposit near Barstow. The Western Borax Co., Ltd., near Kramer was succeeded by the United States Borax Co. in 1933; no operations were carried on in 1934. Boric acid also was produced by the American Potash & Chemical Co.; this product, calculated as borax, is included with sodium borate in the figures for sales from 1931 to 1934. A small quantity of mixed ulexite and colemanite (calcium borate) was produced, chiefly during development work, by Borax Mines, Inc., at the Russell mine near Death Valley Junction, Inyo County.

[1] Tyler, Paul M., Sodium Sulphate: Inf. Circ. 6833, Bureau of Mines, 1935, 39 pp.

Foreign trade.[2]—Exports and imports of sodium sulphate and borax are given in the following tables; figures for sodium carbonates are not given, as they would include largely manufactured sodium salts and therefore would not be comparable with the figures for natural salts contained in this report.

Exports of sodium sulphate were small in 1933 and 1934 and were not recorded separately. Total imports of sodium sulphate in 1934 decreased 11 percent in both quantity and value compared with 1933; decreases were shown for all grades of these salts. Exports of sodium borate (borax) in 1934 increased 18 percent in quantity and 16 percent in value from 1933. No crude sodium borates were imported in 1934; imports of the refined product decreased 68 percent in quantity and 71 percent in value compared with 1933.

Sodium sulphate exported from the United States, 1929–34

Year	Short tons	Value	Year	Short tons	Value
1929	1,666	$53,176	1932	1,435	$24,155
1930	4,436	113,253	1933	(1)	(1)
1931	4,652	75,784	1934	(1)	(1)

1 Not separately classified in 1933 and 1934.

Sodium sulphate imported for consumption in the United States, 1930–34

Year	Crude (salt cake)		Crystallized (Glauber's salt)		Anhydrous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	70,337	$800,432	1,156	$9,241	9,934	$200,143	81,427	$1,009,816
1931	72,746	803,509	924	9,615	10,315	193,041	83,985	1,006,165
1932	61,124	644,074	304	2,848	8,855	153,612	70,283	800,534
1933	99,269	885,306	629	8,677	10,371	179,529	110,269	1,073,512
1934	89,701	799,141	533	4,116	8,409	151,490	98,643	954,747

Crude sodium sulphate (salt cake) imported into the United States, 1933–34, by countries

Country	1933		1934	
	Short tons	Value	Short tons	Value
Belgium	35,610	$330,114	17,794	$152,256
Canada	12,423	109,329	3,647	34,198
Chile	8,564	51,176	1,091	4,566
Germany	38,110	354,246	63,270	565,887
Mexico	25	179		
Netherlands	4,063	37,426	3,634	39,656
Spain	474	2,836		
U. S. S. R. (Russia)			265	2,578
	99,269	885,306	89,701	799,141

2 Figures on exports and imports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Imports of crude sodium sulphate (salt cake) in 1933 and 1934 were distributed by customs districts as follows:

Crude sodium sulphate (salt cake) imported into the United States, 1933–34, by customs districts, in short tons

Customs district	1933	1934	Customs district	1933	1934
Atlantic ports:			Pacific ports and Canadian border:		
Maryland	2,402	3,696	Dakota	7,591	2,410
New York	5,973	743	Duluth and Superior	4,338	797
Philadelphia	1,102		Montana and Idaho	494	439
South Carolina		54	Oregon	8,371	6,130
Virginia	672		Washington	4,155	5,098
Gulf ports:				99,269	89,701
Florida	13,435	17,007			
Galveston	336	1,873			
Mobile	20,801	22,789			
New Orleans	28,768	28,665			
Sabine	806				
San Antonio	25				

The anhydrous sodium sulphate imported in 1934 from Germany amounted to 8,358 short tons valued at $150,285, from Belgium 50 tons valued at $1,162, and from Sweden 1 ton valued at $43. The crystallized product from Germany totaled 521 short tons valued at $3,928, from Argentina 11 tons valued at $176, and from Sweden 1 ton valued at $12.

Sodium borate (borax) exported from the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	82,931	$3,057,794	1933	87,677	$2,498,035
1931	86,938	3,358,609	1934	103,643	2,907,276
1932	89,641	2,677,626			

Sodium borates imported for consumption in the United States, 1930–34

Year	Crude		Refined		Year	Crude		Refined	
	Short tons	Value	Pounds	Value		Short tons	Value	Pounds	Value
1930			16,681	$1,993	1933	1,069	$30,742	1,061	$259
1931	570	$16,507	1,516	251	1934			335	74
1932			610	128					

PRECIOUS AND SEMIPRECIOUS STONES (GEM MINERALS)

By Sydney H. Ball

SUMMARY OUTLINE

Precious and semiprecious stones include minerals used primarily for personal adornment and decorative purposes. To be so prized the stones must have beauty and "fire" or play of color, must not be too common, and must be hard enough to withstand ordinary wear. Among the less regal members of the group fashion temporarily may determine the popularity of a gem stone. The quality of hardness also accounts for the many industrial uses of diamonds and, to a smaller extent, of rubies and sapphires.

Almost 100 mineral substances have been used for decorative purposes, and although there is no hard and fast division of precious and semi-precious stones, diamonds, emeralds, rubies, and sapphires usually are included in the former group and frequently, by courtesy, pearls, an organic substance. These gems, however, sometimes are equaled in beauty by exceptionally fine opals, aquamarines, tourmalines, spinels, chrysoberyls (including cat's-eye and alexandrite), and spodumenes (hiddenite and kunzite).

The diamond industry is organized much more highly than that of any other precious stone, and the diamond output represents almost 95 percent of the world's gem production.

HISTORICAL SUMMARY

Through the ages the precious stone industry has seen notable changes both as to the principal gem mined and the country of its source. From about 25000 to 3400 B. C. the Baltic amber mines dominated the industry. For the next 1425 years the turquoise mines of the Sinai Peninsula were the most important gem mines in the world. From about 1925 to 800 B. C., the emerald mines of the Egyptian Red Sea coast were unrivaled. Thereafter, until 1725 A. D., India and Ceylon, with their diamond, ruby, and sapphire mines, were the world's leading gem producers. They lost this position to the Brazilian diamond mines, which in turn were supplanted in 1870 by the South African diamond mines. For the past 3 years closing of the South African pipe mines has perhaps shifted the weighted center of the world's gem production to northeastern Angola.

United States.—In contrast to its wealth in most mineral resources, the United States is notably poor in precious stones, having no deposits of first rank. The Montana sapphire deposits, the Southwest turquoise mines, the Maine tourmaline mines, and the southern California tourmaline and kunzite mines have produced gems, but no deposit has been found comparable to the Brazilian or South African diamond fields. A few diamonds have been discovered in Arkansas, but mining activity has been sporadic. Semiprecious stones occur near many resorts, but the tourist purchaser of the "local" product more than likely buys a South American stone cut in Germany and mounted in Providence, R. I.

In spite of the fact that no outstanding deposits of any one stone has been located in the United States, probably no other country has yielded such a wide variety of precious and semiprecious stones; more than 60 distinct species have been produced commercially. Gem mining is an old, if not important, American industry. When white men began their conquest of America they found that the Indians of North and South America used about as many decorative and precious stones as were known at that time to the people of Europe, Asia, and Africa. Certain deposits were worked at least 2,000 years ago; one turquoise mine was a major mining project before the Spaniards arrived in America.

Adequate statistics are available only from 1880 to 1924, and during those 45 years about $9,800,000 worth of gems were produced; the peak year was 1909 ($534,000) and the year of least production, 1923 ($60,000); these figures cover the most active period of gem mining in the United States. Including estimates of production from 1925 to the present the total value of precious stones produced in the United States has been about $10,500,000. Montana, the largest producing State, has been responsible for about 48 percent of the total value, followed by California and Nevada with 23 and 8 percent, respectively.

From 1883 to 1921 the United States produced sapphires (as well as a few rubies) valued at $3,018,406; turquoise and matrix, $2,088,262; quartz gems, $1,894,289; tourmaline, $822,955; garnet, $173,979; beryl, $138,186; and variscite, $125,718.

The Mount Mica tourmaline locality in Maine has been worked in a desultory manner since it was discovered in 1820, but the first American gem-mining concern was the Emerald & Hiddenite Mining Co., which exploited the emerald and hiddenite deposit at Stony Point, N. C., from 1880 to 1888. However, its total production is said to have been valued at only $22,500. Since then several other companies have been formed to mine emeralds in North Carolina.

About 1900, there were extensive mining operations at several turquoise mines of the Southwest, notably at Los Cerillos and in the

Burro Mountains, N. Mex. Good-quality material was recovered in appreciable quantities, and if turquoise should regain its former popularity the mines no doubt would be reopened.

Fifty years ago the agatized wood of Arizona was cut and polished on a scale that threatened to destroy the beauty of the petrified forest, but this menace disappeared when the forest became a national park.

Sapphires were found first in Montana in 1865 in the sluice boxes of placer mines along the Missouri River. From 1880 to 1890 several thousand dollars worth were produced annually as a byproduct of placer mining. Shortly after 1890 the gem was found to occur in a basic igneous dike, and in 1896 an English company began mining. The work was suspended in 1929, but production in some of the intervening years reached $450,000 annually. Some brilliantly attractive, though rather pale, gems were recovered and sold in London, Paris, and New York, although 85 percent by weight of the production was shipped to Switzerland to be cut into jewels for watches.

In 1906 diamonds were found near Murfreesboro, Pike County, Ark., the source being a rock very similar to the kimberlite of the

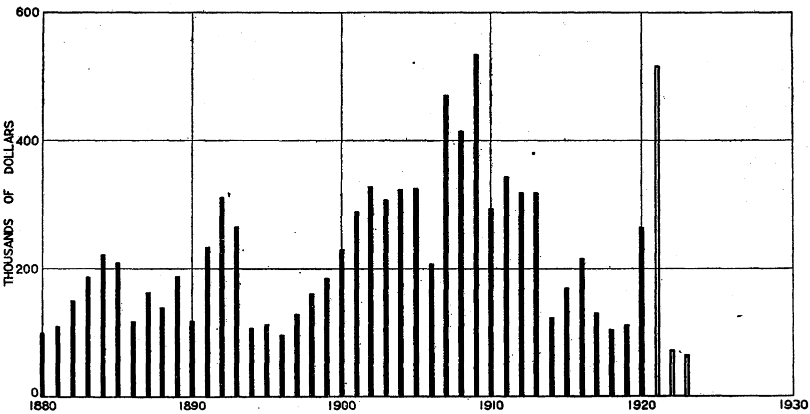

FIGURE 129.—Value of precious and semiprecious stones produced in the United States, 1880–1923.

South African pipes. Several companies were formed at once, but to date production has totaled only about 10,000 carats, and for the past 2 years none of the companies have operated.

Beautiful tourmaline of various colors has been produced at Mesa Grande, San Diego County, Calif., and the pink variety has been exported to China for cutting. Kunzite, the attractive, transparent, lilac spodumene, is obtained from the same district. The Virgin Valley, Nev., has produced some fine black opals and Latah County, Idaho, some attractive gem opals. The moss agates of Montana and Wyoming are as fine as any in the world. A number of other semiprecious stones of American origin come on the market from time to time, notably aquamarine and golden beryl, agates and other quartz gems, amazon stone, malachite, and azurite. The ornamental use of gold quartz originated in California over 80 years ago. The deep blue benitoite (California), the emerald-green hiddenite (North Carolina), the yellowish green variscite (Utah), and the rose-red rhodolite (North Carolina) are found only in the United States.

In addition to the output of gem-mining companies mineral collectors from time to time find gems worthy of cutting, and farmers near Hot Springs, Ark., collect and even mine considerable quantities of rock crystal. Other gems are byproducts of mica, feldspar, or corundum mining.

Canada.—Canada is perhaps even poorer in precious stones than the United States, and little gem mining has been done; however, there are deposits of amazon stone, albite (the iridescent variety, peristerite), sodalite, rose quartz, garnet, and agate, the product of which when cut makes attractive beads.[1] Small amounts of rose quartz are reported to have been shipped to Germany late in 1933 or early in 1934 from the Winnipeg River area, Manitoba.[2]

Mexico.—Mexico is almost equally poor in precious stones, although opals have been mined and cut for centuries. The opals, while attractive, scarcely are comparable to those of Hungary and Australia.

Production in the United States.—The value of precious stones produced in the United States in 1934 probably did not exceed $3,000, including 2,000 pounds of rose quartz from South Dakota; amazon stone from Amelia Courthouse, Va.; variscite from Utah; vesuvianite from Tulare County, Calif.; topaz from Fresno County, Calif.; four diamonds from the California gold placers; and agatized wood from Arizona. Amateur lapidaries also collected and cut some semiprecious stones from other States. Spencer[3] describes a new gem stone, pollucite (an acid silicate of caesium and aluminum) from Newry, Oxford County, Maine. The cut stone, a brilliant of 1.725 carats, is colorless and flawless with a brilliant luster.

Imports.—According to the Bureau of Foreign and Domestic Commerce, imports of precious stones into the United States in 1934 were as follows:

	Carats	Value
Diamonds:		
Rough, uncut	43, 754	$2, 739, 278
Cut, but not set	208, 916	9, 900, 900
Glaziers', engravers', and miners', not set	520, 889	2, 810, 281
Pearls and parts, not strung or set		477, 018
Other precious stones:		
Rough, uncut		115, 333
Cut, but not set		774, 238
Imitation precious stones, except opaque		1, 051, 608
Imitation precious and semiprecious stones, opaque, including imitation pearls		24, 992
Marcasites		14, 956

The rate of duty on various types of gems and their imitations remains the same as that given in Minerals Yearbook, 1932–33, page 803.

Status of jewelry trade.—Judged by sales as well as number of employees and wages paid, the jewelry trade had an appreciably better year in 1934 than in 1933. Jewelry sales were larger than those of 1933, but only about 45 percent of those of 1929. The increase was largely in low-priced goods, but an occasional fine gem was sold, and toward the end of the year there was a distinct improvement in the demand for fine jewelry. Furthermore, for the first time in several years jewelers were able to mark up their inventories, due to an upward price trend. Manufacturing jewelers had a reasonably satis-

[1] Parsons, A. L., University of Toronto Studies 36: Contrib. to Canadian Mineral., 1934, pp. 13–21.
[2] Hutt, G. M., and Seibert, F. V., Bull. Canadian Min. and Met., June 1934, p. 330.
[3] Spencer, L. J., Gemmologist, April 1934, pp. 263–264.

factory year, and from September to December many of them operated their plants to capacity.

Taxes and codes.—On May 10, 1934 the Federal Government removed the 10-percent sales tax on jewelry sold for less than $25 and on materials for watches and clocks. For the fiscal year ended June 30, 1934 the tax was collected on sales of $46,685,570, including those articles sold at a wholesale price of more than $3. New York contributed 39.6 percent of the total, Illinois 12.3 percent, and Massachusetts and Pennsylvania 7.7 percent each.

The jewelry industry in 1934 operated under several codes. Although entailing an additional expense to the code members and meeting objection from a few individuals the codes in general have improved the morale of the industry. Provisions for adjusting certain discrepancies between the various codes would have been helpful.

Foreign tariffs and taxes.—On July 6, 1934, the Doumergue government suppressed the "luxury" tax, to the advantage of established French jewelers and the discomfort of jewelers who did not maintain their own establishments.

In South Africa most industries pay an income tax of 2s. 6d. per £1, but diamond mines pay 3s. and gold mines 4s.

The high Indian duties are bringing many smuggled stones on the local market, which is disadvantageous to honest jewel merchants.

On December 24, 1934, Italy prohibited the importation of all precious stones but in February 1935 changed to a plan of controlled imports. This measure hurts not only the diamond-cutting centers of the world but the 40,000 employees of the Italian jewelry industry as well. In the past, Italy has had a considerable jewelry export trade with South America and the Balkans, although imports of unmounted precious stones were double exports in 1934.

Czechoslovakia, in an attempt to preserve its trade balance, prohibited the imports of precious stones early in 1935. Jewelers therefore depend on stocks or on stones derived from old pieces of jewelry.

Imports into Germany are so complicated by government restrictions as to payment that the situation virtually amounts to an embargo.

Identification of jewelry.—At the conference of the International Association of Manufacturers, Wholesalers, and Retailers of Jewelry, Gold, and Silverware in May 1934 at The Hague it was proposed to mark all precious stones, an idea apparently sponsored by the Germans. Others considered that it would be vandalism to mar flawless gems but agreed that it might be a good idea to mark synthetic stones. Additional methods of identifying fine stones were considered, and it was reported that an English expert, P. Antrobus, has made plaster casts of some 50,000 of the finest pieces of jewelry owned in Great Britain, as well as detailed descriptions of the stones.

Fashions in jewels.—Bar clips, ear clips, long diamond pendant earrings, and solitaire diamonds for hair ornaments were popular adornments during 1934. Designs were inclined to affect the bizarre, with Hindoo, Cambodian, Egyptian, or Russian motifs. Diamonds and sapphires, the latter the stone of Princess Marina's engagement ring, were particularly popular. Toward the end of the year there was a distinct trend toward the use of single large jewels of fine quality. In diamonds, the brilliant appears to be gaining in favor over the square or emerald cut. In demanding large stones of the finest quality, women of today in part may be activated by their investment value.

Traditionally the use of platinum is linked with fine diamond jewelry, the demand for which was subnormal in 1934. Due to the high price of gold, however, platinum was used in 1934 for rings and other jewelry, cigarette cases, and other personal ornaments customarily made of gold.

Century of Progress exhibit.—In 1934, as in 1933, diamonds were featured at the Chicago Century of Progress. The more important features of the 1933 exhibit were retained, and the addition of the exquisite La Favorite (50.28 carats) brought the value of large diamonds on exhibit—including the Tiffany Yellow (128.5 carats) and the blue-white Maximilian diamond (42 carats)—to over $2,500,000. Diamond cutting was done in the streets of Amsterdam concession, and Mme. Sarah Bernhardt's jewels were displayed in Burma House in the English Village.

DIAMOND

Conditions in the diamond industry improved moderately in 1934. Real prosperity, however, depends upon resumption of normal business, particularly in the United States. Unification of the production and sales branches of the industry progressed during the year. Two factors were disturbing—a slight increase in production without, however, adding to stocks; and the tendency of the cutting industry, organized to meet great demand, to sacrifice present profits to maintain its existence.

A poor beginning in the first 5 months of the year was more than balanced by the reasonably good and at times excellent business of the last 7 months. Sales of rough diamonds by the corporation were appreciably higher than in 1933; exports from South Africa were 30 percent higher; imports into the United States increased 26 percent; and world retail sales were 20 to 25 percent above those of 1933. Stocks in the hands of retailers are now low, and provided conditions improve sales of rough should be large in 1935. Prices fluctuated considerably during the year. Rough was about the same at the end of the year as at the beginning; fine-cut stones increased slightly; and small polished stones, due to too keen competition among the cutters, dropped a little.

Share dealings.—Trading in diamond shares was of small volume during 1934 except in January, November, and December. Share prices advanced from the beginning of the year until mid-February; then the general price trend was downward until November. Prices, however, increased appreciably in December. Six of ten important diamond shares advanced during the year, notably West African Diamond Syndicate, Angolas (Diamang), and De Beers preferred; and four lost, Jagersfontein and Consolidated Diamond Mines being the heaviest losers. The net result for the year was an average advance of about 9 percent. At the end of 1934 five selected stocks were about 36 percent of the all-time high (1927) and 406 percent of the all-time low (June 1932). Of the 18 principal diamond-mining companies 10 paid dividends.

Market.—About 95 percent of the world's diamond production is purchased by the Diamond Corporation, London, which in turn sells to brokers and large cutters. In 1934, as usual, the corporation was astute, keeping prices of rough firm and rarely selling rough except when the resulting cut product could be absorbed. By making no concessions as to the price of rough the corporation doubtless will aid in raising the price of cut stones to a level profitable to the cutters. During the summer polished goods were too low by 15 to 20 percent in comparison to rough, a differential since decreased.

The Diamond Trading Co., the new selling subsidiary of the corporation, made its first sale under the new sorting agreement on May 8, 1934. Although the corporation does not publish its sales they are understood to have been about £4,000,000, a relatively low figure, but considerably higher than in 1933. The large stock of rough held by the corporation decreased slightly for the first time in several years.

Contracts with non-South African producers terminated at the end of 1934, but new contracts have been negotiated. It is stated that the corporation is to make five-eighths of its sales from stones produced by the South African mines and three-eighths from the outside producers (Congo, Angola, and Gold Coast).

The market outlook inspired confidence at the beginning of the year due to the producers' agreement consummated late in 1933 and to expectation of a better American market. January and February sales were appreciable, but quantities of Russian "seconds" reached western Europe in the first 4 months of the year, and it was not until June and July that considerable sales of rough again were made. September, October, and November were months of large sales, the best the corporation has had in several years and much higher than seasonal. December, as usual, was a dull month, but large sales of rough were made early in 1935, so that the trade is inclined to face the future confidently.

The poor market for cut stones during the first 5 months was offset by distinctly better business for the balance of the year. The first 4 months were quiet to dull, with too much cut offered on a thin market. Improvement was noted in May and from then on confidence grew, culminating in large sales in September, October, and November with price increases in certain types and an actual shortage of supply in others.

In the United States more interest was shown in diamonds in 1934 than in 1933. Except from May to September wholesale sales in New York were appreciably greater compared with corresponding months in 1933. The average monthly gain over 1933 was 19.2 percent. For the first half of the year the increase was due to larger sales of cheaper goods. In October, American buyers in Europe bought heavily of good quality meleés and large stones in anticipation of the Christmas trade, and by December American buying reminded European centers of old times. The Christmas trade improved 25 to 30 percent over 1933, with much inquiry for and some buying of large stones.

Diamond sales in Great Britain in 1934 exceeded those of 1933 by perhaps 25 percent, the diamond trade evidently being slowly on the upgrade. The market was strong late in the year due to the marriage of the Duke of Kent and Princess Marina. Sales in other European countries improved, except in France, Germany, and Russia. For the past 3 years India has been even a larger buyer than usual.

Imports of precious stones into India, largely diamonds from Belgium, were about $2,000,000 in the fiscal year 1933–34.

The purchase of precious stones, especially diamonds, as a hedge against inflation was more wide-spread in America in 1934 than in 1933. The stones purchased were fine, unset stones of 1 to 10 carats, the type of most stable price. Many sales of rough in December were to satisfy the desires of continental investors, as was also the demand for large stones from June to August. Germany, Hungary, and France undoubtedly bought many fine diamonds as investments during the year.

Following England's abandonment of the gold standard in the fall of 1931 India sent large quantities of gold to England. A large part of the proceeds of these sales was used in purchasing fine diamonds, rubies, emeralds, and sapphires.

Stocks.—The Diamond Corporation's stocks, as well as those of producers and cutters in Amsterdam and Antwerp, remained large, probably a little less than they have been for the past 3 years or approximately about $100,000,000. In America, wholesalers' stocks are believed to have increased nearly 10 percent in 1934 but are still low. Retailers' stocks also are very small and if the present demand continues must be increased materially. This is equally true of retailers in England, Italy, Austria, and Hungary. Should real prosperity return to the trade large purchases must be made from the corporation and the cutters who buy from it.

Prices.—The price of rough began to sag slightly in February and did not recover until May, with the result that prices for the first half of 1934 were less than in the corresponding period of 1933 by perhaps 10 percent. From May to October prices were firm, and in October certain types were advanced from 5 to 7½ percent. In short, rough ended the year at about the same price as the beginning, but with promise of improvement in future. Prices for fine large cut were firm throughout the year. The price of large cut stones is determined by the price of rough, but due to the large amount of labor involved the cost of polishing is the major factor that determines the price of small stones. Due to the dumping of small cut stones by the German cutting industry, with its low labor costs, and also to the keen competition of Amsterdam and Antwerp cutters, the price of small cut fell from January to April, and in June such goods were selling in America at distress prices. In Europe, however, prices for certain classes of small stones became firm by May, and thereafter the price tendency was upward. The net result of fluctuations during the year was a slight increase in the price of large stones and a small decrease in that of small stones.

Imports into the United States.—In 1934 cut and uncut diamonds (not including industrial stones) comprised 84 percent of the imports of all precious stones, pearls, and imitation stones; excluding imitation stones as well, diamonds accounted for 90 percent of the total.

The value increased 126 percent from 1933, although it was equivalent to only 44 percent of the 1929 total. The price per carat of both cut and uncut exceeded the corresponding 1933 figure, and that of the rough was unusually high. The total value of imports of rough and cut diamonds in 1934 was $12,640,178.

Diamonds imported into the United States in 1934, by countries

Country	Rough, or uncut			Cut, but not set		
	Carats	Value		Carats	Value	
		Total	Per carat		Total	Per carat
Belgium	23,397	$1,649,493	$70.50	145,266	$6,785,871	$46.71
British Guiana	259	3,600	13.90			
Canada	5,234	57,684	11.02	335	23,786	71.00
France	464	137,002	295.26	301	22,854	75.93
Germany				79	8,972	113.57
Italy				37	7,823	211.43
Mexico				4	510	127.50
Netherlands	3,862	257,757	66.74	62,523	3,028,815	48.44
Switzerland				2	172	86.00
Union of South Africa	6,903	407,557	59.04	66	6,796	102.97
United Kingdom	3,635	226,185	62.22	303	15,301	50.50
	43,754	2,739,278	62.61	208,916	9,900,900	47.39

In 1934, Belgium with 68.6 percent and Netherlands with 30.6 percent accounted for 99.2 percent of the American imports of cut stones. The chief sources of rough were: Belgium, 58.7 percent; Union of South Africa, 14.5 percent; Netherlands, 9 percent; and United Kingdom, 8 percent.

The value per carat of cut imported into the United States reached a peak of $100.07 in 1929. For the succeeding 3 years the value per carat fell, due in part to decreases in diamond prices but largely to the diminished purchasing power in the United States, resulting in purchases of smaller stones of poorer quality. The slight increase in the 1934 price per carat compared with 1932 and 1933 is encouraging.

Imports of rough vary greatly from year to year and normally do not depend directly on good or bad times. Imports reached their peak value in 1926, then decreased to 1932, but have increased somewhat in the past 2 years. The peak in total carats imported was reached in 1929. As indicated by the value per carat the quality of stones imported decreased from 1926 to 1930, picked up appreciably in 1931, fell again in 1932, and then rose sharply in 1933 and 1934.

As usual, the heaviest imports were in the fall in preparation for the Christmas trade.

Per-capita diamond consumption in Canada is about one-half that of the United States. In 1934 imports into Canada were valued at $544,540, an increase of 64 percent over 1933.

Diamond cutting.—The diamond-cutting industry experienced difficulties in 1934. Few cutters made profits, and bickering was rampant, although unemployment was slightly less acute. The number of cutters now exceeds that in peak years, and the master cutters are inclined to polish goods without regard either to profit or world demand. Once a particular cut, size, or grade is desired all rush in to produce it, and a surplus with weakened prices frequently results.

Employment in Antwerp averaged about 42.5 percent of the union membership (41 percent in 1933) and in Amsterdam 33.5 percent (27 percent in 1933). Antwerp with 20,000 to 25,000 artisans, Amsterdam with 5,000, and Hanau and other German cities with 4,500, are the principal cutting centers. Kimberley, Capetown, Johannesburg, New York, Paris, London, Jura Mountains, Geneva, Rio de Janeiro and

Diamantina, and several cities in India and Borneo are minor cutting centers.

Antwerp suffers from German competition; furthermore the cottage industry now scattered throughout Belgium cuts small goods at ridiculously low prices and union hours are unknown. In May and again in October representatives of the Belgian and German industries met at Luxemburg, but the Belgians' efforts to equalize wages in the two countries failed. The Antwerp diamond clubs have forbidden their members to send rough to Germany to be cut, but diamonds are easily smuggled across boundary lines. On October 26 the Belgian Government attempted to stop German "dumping" by requiring all obligations to German manufacturers to be paid through the Belgian National Bank with marks at the regular exchange rate. A Belgian professional school in which young and old workmen will learn improved technique and in which mechanical methods of cutting are taught was founded on March 28, 1934. The Antwerp Diamond Corporation (Comptoir Diamantaire Anversois) formed late in January 1934 (capital 30,000,000 francs) will obtain a better distribution of credit, particularly in the diamond market but also in that of other gems as well as precious metals.

The Amsterdam industry was even less prosperous than that of Antwerp, as it had to compete not only with Germany but also with Belgium, where lower wages are paid than in Holland. The subsidy to cutting of small stones and the contribution by the Dutch Government and the city of Amsterdam of 10 guilders a week per man has, however, resulted in relatively less unemployment in Amsterdam in 1934 than in 1933. Under the circumstances, the diamond cutters union agreed to substantial wage cuts.

At Hanau, Idar, and Brucken, Germany, small stones are cut well and cheaply because the industry is highly mechanized and wages are low. Unemployment, however, has been high; only 10 percent of the cutters were employed early in 1934, but later the situation improved and about 30 percent were employed. Not only did the German Government assist the master workmen by permitting them to pay their men in depreciated currency but it flooded Antwerp with circulars setting forth the advantage of having cutting done in Germany and having the work paid in "dollar bonds." In future German competition may be even more severe, for the industry has been rounded out by the addition of sawing and grinding units.

The South African cutting industry is slowly dying. The number of employees has dropped from 676 in 1929 to only 250 in 1934. The government apparently has definitely abandoned additional fostering of the industry.

The increase of 65 percent of rough imported into the United States in 1934 compared with 1933 suggests that the American cutting industry may revive. In 1934, 60 to 75 artisans were employed spasmodically.

The Parisian industry is virtually at a standstill.

Attempts at artificial production.—Usually every year at least one chemist reports that he has made artificial diamonds. M. K. Hoffman, a German mineralogist, repeated Dr. Henri Moissan's famous experiments and produced synthetic "diamonds." Tests, however, showed that these minute carbon particles had a refractive index of but 1.74 (diamond, 2.4) and hence were not diamonds but apparently some other form of carbon. Hans Karabacek, a Viennese inventor, claimed in 1934 (German patent 589144) to have made diamonds up to 0.25 carat. He melted iron filings, blast-furnace slag, and carbon under a pressure of 20 to 35 tons per square inch and at rather moderate temperatures (900° to 1,000° C.) and then added carbon monoxide or carbon dioxide.

World production.—World production of diamonds in 1934 was approximately 4,179,581 carats valued at $18,469,923, an increase of 21 percent in quantity and 33 percent in value compared with 1933.

The following table gives, with the accuracy available statistics permit, diamond production for the past 5 years in carats:

Production of diamonds by countries, 1930–34, in carats

Country	1930	1931	1932	1933	1934
South Africa:					
Mines	2,242,460	1,470,376	307,431	14,149	430,897
Alluvial	918,706	647,044	488,096	492,404	9,413
	[1] 3,163,590	[1] 2,119,155	[1] 798,382	506,553	440,310
Angola	329,823	351,495	367,334	[2] 374,000	453,000
Brazil	115,000	80,000	34,000	[2] 30,000	[2] 30,000
British Guiana	110,042	63,479	61,780	48,569	[2] 44,818
Congo	2,519,300	3,528,200	3,990,069	1,604,700	1,992,865
Gold Coast [3]	861,119	880,479	842,297	863,722	1,142,268
Sierra Leone	--------	--------	749	32,017	70,000
South-West Africa	415,047	71,532	17,944	--------	1,100
Tanganyika	13,107	7,790	1,391	[2] 1,250	1,220
Miscellaneous [4]	3,000	3,600	3,725	1,825	4,000
Grand total	7,530,028	7,105,730	6,117,671	3,462,636	4,179,581

1 Includes a small quantity of diamonds recovered from re-treatment of tailings.
2 Estimated.
3 Exports year ended Mar. 31.
4 1930–33, includes India, Borneo, New South Wales, and in certain years Venezuela, French Equatorial Africa, United States (Arkansas), and Rhodesia; 1934, includes Borneo, India, New South Wales, Venezuela, Rhodesia, United States (California).

The increased production over that of 1933 came from Sierra Leone, a new and growing producer, Gold Coast, Angola, and Congo. The value of the 1934 production was only about one-fourth and the quantity about one-half that of an average predepression year due in part to lower prices now received by the producers compared to those of former years but mainly to the relatively large percentage of bort produced by one of the Congo producers and by the Gold Coast.

In addition to newly mined diamonds there is also available to consumers a considerable quantity of "seconds." A few diamonds come on the market for resale every year, but, in addition, for the past 8 years Russia has sent many diamonds to western Europe. In the first 4 months of 1934 the amount received was so great that it was a distinct menace to the stability of the market. Since then shipments from this source have been halted, at least temporarily, but further sales by the Soviet Government are to be expected in future.

South African sales agreement.—The agreement [4] entered into by the South African Government and the South African producers was signed in 1934. Parties to the agreement are the Union Government, the Administrator of Southwest Africa, the Diamond Corporation, and the Diamond Producers' Association, with a board composed of 2 representatives of the companies, 2 of the governments, and 1 of the

4 Minerals Yearbook, 1934, p. 1087.

Diamond Corporation. Stocks are sorted at a single office at Kimberley, and sales quotas for each producer, including the Government as one of the producers, have been established. Sales, including sales to South African cutters (at London prices less the export tax), are made through The Diamond Trading Co., Ltd., owned by the Diamond Corporation. The Trading Co. maintains offices in London and Kimberley. To maintain prices the board can purchase alluvial goods in the open market and can on the other hand fix minimum prices for the sale of its diamonds. Throughout the negotiations the representatives of the coalition government showed their desire to safeguard the stability of the diamond industry. Apparently, it is understood that for the time being the cutting industry in South Africa is not to be expanded, that few new alluvial fields are to be opened to exploitation during the depression, and that the Government accepts a quota for its Namaqualand mines present and future. The Diamond Corporation, to allay fear that its stock might be thrown upon the market, agrees to consider itself a producer and like other producers to accept a sales quota. In other words, the corporation stock will be liquidated over a period of years. Havenga, minister of finance for the Union, stated that once demand improved markedly the Government would forego its Namaqualand quota in favor of the Kimberley, Jagersfontein, and Koffyfontein pipe mines. The sales quotas are as follows: South African Government, 10 percent; Diamond Corporation, 31.5 percent; De Beers, 30 percent; Consolidated Southwest Africa, 14.5 percent; Jagersfontein, 6 percent; Premier, 6 percent; and Cape Coast Exploration, 2 percent. This agreement assures two basic needs of the industry—(1) control of South African production and (2) sales of South African diamonds through one channel.

Government officials state that they desire to improve the position of an industry which supports tens of thousands of miners and diggers. As proof they cite that in 1930 Government sales totaled 97,000 carats and those of South African producers 23,000 carats, whereas in 1933 the Government sold but 23,000 carats and producers 119,000 carats.

South African production.—In 1934 South Africa produced 440,312.57 carats of diamonds with an estimated value of £1,437,591. This quantity was equivalent to about 90 percent of production in 1933 but only about 8 percent of that in 1913, the peak year. Except for a few gems from mine tailings (9,413 carats valued at £5,474) production came from alluvial diggings.

Cape Colony furnished 64.1 percent of the production; Transvaal, 32.4 percent; and Orange Free State, 3.5 percent.

Production and sales of diamonds in South Africa, 1934

	Production		Sales		
	Carats	Estimated value	Carats	Value	Value per carat
					S. d.
Transvaal	313, 153	£648, 603	507, 745	£807, 371	31 10
Cape Colony	120, 552	778, 091	655, 673	1, 598, 514	48 9
Orange Free State	6, 606	10, 897	98. 128	87, 263	17 9
	440, 311	1, 437, 591	1, 261, 546	2, 493, 148	39 6

Production of diamonds in South Africa in 1934, by alluvial fields

Field	Metric carats	Value	Value per carat	Field	Metric carats	Value	Value per carat
Transvaal:			S. d.	Cape Colony—Con.			S. d.
Klerksdorp	46,859.75	£192,722	82 3	Vryburg	19.25	£97	
Lichtenburg	240,177.75	359,056	29 11	Taungs	27.75	89	
Pretoria	26,116.25	96,825	74 2	Gordonia	53.75	459	
	313,153.75	648,603	41 5	Van Rhynsdorp	.95	3	
					115,331.77	774,003	134 3
Cape Colony:				Orange Free State:			
Kimberley	5,705.00	32,272	113 2	Boshof	1,309.25	7,099	108 5
Namaqualand	68,754.25	550,010	160 0	Winburg	979.00	1,823	37 3
Barkly West	30,053.22	141,953	94 6	Hoopstad	3.25	15	92 4
Herbert	6,343.50	27,899	88 0	Kroonstad	6.75	24	
Hay	20.50	27	26 4	Vredefort	114.80	550	
Prieska	876.25	5,337	121 10				
Hopetown	1,888.50	12,088	128 0				
Mafeking	1,588.85	3,769	47 5		2,413.05	9,511	78 10

To December 31, 1934, South Africa has had a total recorded production (in addition to stolen and smuggled stones) of diamonds valued at some £311,637,600, or well over one-fourth of its gold production and almost one-fifth of its total mineral output. During the 15 years 1920–34 South Africa has produced 34,021,794 carats and sold 30,597,574, an excess production of 3,424,220 carats. The lack of balance between production and sales, first apparent in 1927, was due to the exploitation of the Lichtenburg and Namaqualand alluvial fields. Exports in 1932 were £1,955,523; in 1933, £2,131,000; and in 1934, £2,772,000.

The Namaqualand production was again small, virtually all of the valuable claims being owned either by the State or the Cape Coast Explorers, and each is working on a quota basis. Recent production has been as follows:

Year	Carats	Value	Value per carat
			£ s. d.
1929	265,844	£1,748,465	6 11 6½
1930	142,125	1,274,364	8 19 4
1931	137,895	940,946	6 16 4
1932	99,196.6	643,795	6 9 10
1933	50,687.45	393,221	7 15 2
1934	68,754.25	550,010	8 -- --

All the pipe mines were shut down in 1934, but to give employment De Beers began on a small scale in February 1935 to wash some of its stock-piled kimberlite. The mines, however, sold diamonds from stocks on hand, and De Beers, for example, made a profit of £768,683 (£128,589 in 1933).

Sir Henry Strakosch [5] in an interesting article, after pointing out that money made in the diamond mines furnished much of the capital used in opening up the Rand (Transvaal) gold mines, adds the idea that these same Kimberley men, acquainted with the misfortunes arising from small diamond claims (31 feet by 31 feet) and lack of technical skill, determined that the gold mines would be operated as large units with the best technical ability available.

[5] Financial News, Jan. 22, 1934.

New Vaal River, a producer of fine alluvial stones, made a small profit, as did Nooitgedacht Diamonds, Ltd. Carrig Diamonds, Ltd., which in the heydey of the Lichtenburg district paid dividends of 502.5 percent in a single year, acquired several new diamond-bearing properties. Cape Coast Exploration, although not operating, continued to pay dividends from selling diamonds on hand.

Central Africa diamond field.—The northern half of the extensive Central Africa alluvial field, which next to South Africa has produced more diamonds than any other field in history, is worked by five companies operating in the Belgian Congo; and the southern half across the frontier in Portuguese West Africa is worked by Diamang.

Belgian Congo.—Belgian Congo production continued to show the effects of the curtailment program begun in the fall of 1932. For the fourth year in succession, however, it was the largest diamond producer of the world, although surpassed in value by South Africa.

The Congo diamond-mining companies employ about 150 whites and 10,500 blacks. By the use of machinery, especially larger units, and the growing efficiency of labor, the companies are reducing both their costs and the labor force necessary for their operations. Much of the overburden is removed by hydraulic giants, and many of the plants are run by hydroelectric power. The companies keep a large gravel reserve blocked out ahead of exploitation, thereby insuring a long productive life. All five companies pay dividends apparently satisfactory to their stockholders.

In June 1934 the export tax on industrial stones was reduced from 6 to 4 percent, while that on gem diamonds remained at 6 percent. The government valuation placed on gem diamonds, however, was reduced from 70 to 60 francs, and that on industrial stones remained at 8 francs.

The Forminière (Société Internationale Forestière et Minière du Congo) is the original company in Central Africa and, besides its important diamond production, its large interests cover Congo tin and gold mining as well as plantation, trading, and ranching enterprises. Like other large Congo mining companies it is an important source of revenue to the colony. Diamond production for the past 5 years has been approximately as follows: 1930, 338,000 carats; 1931, 429,000 carats; 1932, 490,000 carats; 1933, 402,600 carats; and 1934 (estimated), 472,900 carats. Fifteen mines were operated in 1934.

Beceka (Société Minière du Beceka) produces industrial diamonds mainly, less than 10 percent of its production being suitable for cutting. Approximate production was as follows: 1929, 1,400,000 carats; 1930, 1,969,500 carats; 1931, 2,885,095 carats; 1932, 3,188,000 carats; 1933, 1,487,100 carats; 1934 (estimated), slightly under 1,400,000 carats. All the mines are now operated by hydroelectric power.

Kasai-Luebo-Lueta Companies (Société Minière du Kasai, Société Minière du Luebo, Société Minière du Lueta) exploit their concessions as a unit through the Forminière. Recent production was as follows: 1932, 192,691 carats; 1933 (estimated), 115,000 carats; 1934 (estimated), 132,000 carats.

A few fine diamonds are recovered as a byproduct by the companies operating gold placers in the northeastern part of the colony. Prospectors in 1934 reported the finding of isolated diamonds of no commercial importance in several different parts of the colony.

Portuguese West Africa (Angola).—The colonial government of Angola and Portuguese, French, Belgian, American, and English investors own Diamang (Companhia de Diamantes de Angola, known as "Angolas" on the London Exchange). The diamonds are shipped through the Belgian Congo to the corporation. Operating results in recent years were as follows:

Results of diamond operations in Portuguese West Africa, 1927–34

Year	Cubic meters treated	Carats produced	Carats per cubic meter	Net profit	Dividend per £ share
					s.
1927	203,492	201,511	0.99	£108,433	1
1928	231,980	237,511	1.02	109,110	1
1929	264,323	311,933	1.18	122,032	1
1930	341,708	329,823	.97	109,480	1
1931	397,526	351,495	.88	105,949	1
1932	407,945	367,334	.90	107,908	1
1933	458,940	373,623	.81	109,386	1
1934 [1]	486,000	453,000	.93	(2)	(3)

[1] Estimated.
[2] Not yet available.
[3] Probably at least 1s.; an interim dividend of 1s. was paid on Jan. 14, 1935.

The mines (18 are now operated) are in the northeast corner of the colony. About 12 years' gravel reserves are kept blocked out ahead of production. From the formation of the company in 1917 to the end of 1934 production has totaled 3,486,543 carats. About 110 whites and 5,750 blacks are employed.

To the end of January 1935, £797,360 had been loaned to the colony and £727,020 paid to it as participations in profits. The loan is to be repaid in 25 annual installments, beginning in 1935.

Gold Coast.—The Gold Coast diamond deposits discovered in February 1919 are said to extend over an area of some 20,000 square miles. The stones are small (15 to 25 per carat) but of good quality. The largest diamond yet found weighed 9 carats and was worth £15 5s. Total exports from 1919 to 1934 have been 6,143,728 carats valued at £4,572,537. The estimated gross production in 1934 was about 1,200,000 carats.

All exploitable deposits so far known occur in the Birrim Valley, although a few stones have been found at several other places in the colony. The diamonds occur in stream gravels and drift overlying pre-Cambrian schists, basic lava beds in the schists being considered the source. Operating costs per carat of the principal producers have been reduced appreciably. The producers in 1933 were the Consolidated African Selection Trust, West African Diamond Syndicate, the Holland Syndicate, and Cayco (London), Ltd. Morkwa, Ltd., subleased its five mining leases to a continental group.

The principal producer is the Consolidated African Selection Trust, with concessions covering approximately 54 square miles in the Birrim Valley. It also owns about 32 percent of the stock of Cape Coast Exploration in Namaqualand and all the stock of the Sierra Leone Selection Trust. The latter produces relatively large stones, so that the company hereafter will present for sale a good assortment in sizes. In the Gold Coast it employs about 18 whites and 1,200 blacks. The company does not release production figures but in addition to storing some "rubbish" in Africa exports annually about 900,000 carats. The year 1934 is reported to have been satisfactory.

The West African Diamond Syndicate in 1933 produced 252,900 carats, a 15-percent increase compared with 220,000 carats produced in 1932. The company treats its concentrates in a two-stage magnetic separator and has decreased theft by concentrating all diamond picking at a single station to which concentrates are sent in locked containers.

South-West Africa.—The mandated area of South-West Africa has been hit particularly hard by the world depression, as it depended largely for its revenue upon the production of copper and diamonds, the latter usually comprising 45 to 60 percent of the exports. Production of diamonds in recent years is given in the following table:

Production and sales of diamonds in South-West Africa, 1926–34

Year	Production			Sales		
	Carats	Value	Stones per carat	Carats	Value	Value per carat
						S. d.
1926	683,801		6.7	726,808	£2,050,688	56 5
1927	723,877		5.9	577,341	1,620,862	56 2
1928	503,142		6.3	564,383	1,389,864	49 3
1929	597,187		5.3	533,101	1,617,698	60 8
1930	415,047		5.8	214,036	640,253	59 10
1931	71,532	£208,081	4.8	103,000	300,000	58 2
1932	17,944	85,503	.9	44,000	211,000	95 4
1933	2,674		.7	9,113	57,860	126 11.8
1934	(1)				331,980	

[1] No mines operated, but a few carats no doubt recovered during development.

The principal producer, Consolidated Diamond Mines of South-West Africa, closed its mine in 1932, although since then it has continued successful development work north of Orange River, where it began washing diamonds on a small scale on January 1, 1935. It made a fair profit (£82,155) in 1934 from sales of stones on hand. When times become better again this company no doubt will be one of the first of those participating in the Diamond Corporation to recover, as it has large reserves of a well-varied assortment of diamonds which can be mined cheaply.

Sierra Leone.—In 1930 diamonds were discovered in Sierra Leone by members of the Colonial Geological Survey in the gravels of Kenja River and in the Kono district near the French Guinea border. Prospecting was begun in 1931 by the Consolidated African Selection Trust, Ltd., the principal producer on the Gold Coast. In April 1934 this company formed a subsidiary, Sierra Leone Selection Trust (capital £150,000 in 5s. shares), which has a monopoly of the colony's diamond mining. The Government participates in the profits. The stones produced have a good range as to quality, shape, and size, which aids in marketing them. The development work accomplished so far suggests that the field is important. Production in 1932 and early 1933 was from Shongbo, but in July 1933 the Sefadu deposit was opened, and modern treatment plants are being installed. The estimated production for 1934 was about 70,000 carats.

Miscellaneous producers.—In 1933 British Guiana produced 48,568.88 carats of diamonds valued at $526,486.55 or $10.84 per carat (1932, 60,185.13 carats). An average of 7.5 stones weighed 1 carat and the biggest stone weighed 8.5 carats. Ninety-nine percent of the output came from the Mazaruni district. The 1934 production was 44,818 carats. As the colony's diamond output has decreased its gold production has increased, the "pork-knockers" finding gold mining more lucrative under present economic conditions.

Diamond production in Brazil in 1934 was presumably somewhat less than in 1933. Exports from Bahia in 1933 were 9,590.79 carats of gem stones and 9,397.46 carats of carbonados. A new American-financed company, the Brazil Gold & Diamond Mines Corporation, entered the Brazilian field in 1934.

The diamond production of Tanganyika Territory continued to decline and in 1934 amounted to only 1,220 carats valued at about £1,754. The principal producer of diamonds, Tanganyika Diamonds, increased its capital to £300,000 in 1934 and became the Tanganyika Diamond & Gold Development Co., Ltd., with gold mining its chief interest. Mining was continued at Mabuki on a restricted scale, and a number of good stones were recovered, notably one of 42 carats valued at £1,470. "Yellow ground" (weathered kimberlite) nearby is stated to contain, according to recent washings, diamonds at the rate of 8.04 carats per 100 loads. The company also announced the discovery of a pipe in the Shinyanga district, but its diamond content is unreported as yet.

In 1933 India produced 2,342 carats of diamonds, a considerable increase over recent years (1931, 639 carats; and 1932, 1,254 carats). Most of these came from the Panna State, Central India. India, once the chief source of all the world's diamonds, now imports annually $1,500,000 to over $3,000,000 worth of diamonds.

In 1934 Venezuela produced a few carats of diamonds, perhaps 1,000, from the gravels of the Caroni River. These either were smuggled out or were exported through British Guiana.

In August 1934 it was announced officially that a diamond had been found in placer mining near Birnin Gwari in Zaria Province, and another in the Sokoto River, Sokoto Province, Nigeria. The first stone weighed 0.5 carat and the second over 10 carats. A rush was about to start when the government prohibited further prospecting.

In 1933 New South Wales produced 123 carats of diamonds, the lowest figure in recent years (1930, 677 carats; 1931, 725 carats; 1932, 251 carats). The average price received was about $5 per carat.

Southern Rhodesia again became a diamond producer in 1934 in a modest way, as 12 carats were recovered in November. Two diamonds are reported to have been found in the Limpopo River gravels north of Messina. Its total production has been 15,793.35 carats, worth about £75,273.

W. W. Bradley, State mineralogist, states that four diamonds were recovered in 1934 in California as a byproduct of placer gold mining. The largest (2.57 carats) was found by Robert Echols in Fig Indian Creek, Amador County. The other three were smaller and were found in the Yuba River, in Yuba County, near Smartville.

Borneo, once an important diamond producer, still produces a few stones, and its cutting industry imports a fair quantity of rough from

South Africa. During the past 10 years its production has averaged about 460 carats.

Industrial diamonds.—As industrial diamonds are used widely, not only in heavy industries but also for special precision purposes, their sales are a good business barometer.

World sales were relatively large throughout 1934 probably about 50 percent above 1933. Total sales in former years of greater business activity amounted to some $10,000,000 annually. The trade receives its industrial diamonds from three principal sources: (1) From the Diamond Corporation, sold by it as industrial diamonds; (2) from cutters and brokers, representing that part of their purchases from the corporation not suitable for gem stones; and (3) from sources other than the corporation, including notably Brazilian carbonados.

Stocks of good industrial diamonds are now small, for the South African pipe mines responsible for over half the supply are closed and the Brazilian production of carbonados is far below average.

Imports of industrial diamonds into the United States during the past 8 years are given in the following table. The price per carat fell from 1929 to 1933 due to the larger imports of very small and hence cheap, off-color, gem stones for diamond drilling. Seventy-three percent of the imports come from Belgium, the United Kingdom, and the Netherlands.

Industrial diamonds imported into the United States, 1927–34 [1]

Year	Carats	Value	Value per carat	Year	Carats	Value	Value per carat
1927	34, 645	$2, 149, 912	$62. 06	1931	224, 970	$2, 400, 879	$10. 67
1928	38, 342	2, 756, 895	71. 90	1932	163, 704	1, 061, 823	6. 48
1929	46, 901	4, 060, 577	86. 58	1933	258, 300	1, 246, 748	4. 83
1930	145, 958	2, 756, 630	18. 89	1934	520, 889	2, 810, 281	5. 40

[1] Includes glaziers', engravers', and miners' diamonds.

Imports into Canada in 1934 were worth $1,395,404, more than three times those of 1933.

The year 1934 opened with a price increase of about 20 percent and with a good demand for better-grade industrial stones. Throughout the year prices tended to increase, due to the scarcity of fine industrial diamonds; those of fair size reached predepression prices, as also did fine, off-color gem borts for diamond drilling. The supply of such goods is small, and substitution of lower-grade diamonds eventually will be necessary. With this in view, some producers have carried on extensive drilling campaigns in a number of mining districts, using "common industrial goods" instead of borts with apparent success. To indicate the extent of diamond drilling it may be added that in Ontario 265 drills employing 503 men drilled 179 miles of holes in 1934 (corresponding figures for 1933, 143 drills, 251 men, and 107.7 miles of holes). In 1934 this drilling consumed 35,968.44 carats of borts, 32.23 carats of ballas, and 2,004.42 carats of carbonados.[6]

The use of diamonds for dressing emery wheels, shaped diamond tools for factory use, and diamond dies for wire-drawing expanded during 1934.

Due to the rather depressed condition of the precious stone-cutting industry, diamond dust and its source, crushing bort, was low in price

[6] Ontario Dept. of Mines, Toronto, Bull. 98, 1935, pp. 7–8.

throughout the year, although it was somewhat firmer in May and again in August. An ample supply of this grade also came on the market, much of it from the Congo and West Africa. The price was only one-tenth that of 1928, and while the low price did not increase consumption, a new use has been found for this material, and its future looks brighter. The leading abrasive companies are increasing their research as to employment of diamonds, thus in a practical way conceding the marked preeminence in hardness of diamonds over any other natural product or any artificial substitute. The General Electric Co., for example, is reported to have improved tungsten carbide as an abrasive by embedding diamond particles in it. In 1934 the Carborundum Co. exhibited its new diamond wheel at the National Metal Congress (New York, Oct. 1–5). Crushed diamonds accurately sized are embedded in a secret bond molded to the diameter desired; this is then backed by a composition wheel of the size desired. It is used for grinding and shaping hard alloy tools and should eventually find many uses, perhaps even in polishing diamonds, cutting glass, or similar purposes. The Norton Co., together with several European firms, is reported to be making similar wheels. In fact, in Europe wheels of this kind were on the market as early as 1933. This new use should increase the consumption of crushing bort greatly, for the larger wheels contain several hundred carats of diamonds.

Diamond-set tools for dressing abrasive wheels consist of a single stone or of a number of small stones in a proper binder, the latter innovation being one of the reasons for the larger imports of small stones and smaller consumption of black diamonds. The use of such tools has been increasing each year.

The demand for black diamonds or carbonados increased in 1934, particularly in small sizes. Carbonados still are essential for diamond drilling in badly fissured ground. Large-size carbonados, on the other hand, have not been cheaper for the past 40 years. The normal annual production, all from Brazil, is about 25,000 carats; in 1933 it fell to perhaps 8,000 carats but increased to about 18,000 carats in 1934.

OTHER GEM MINERALS

Amber.—Increased sales late in 1933 reduced amber stocks sharply, and mining was resumed in Prussia early in 1934, employing 375 men 40 hours per week. At Palmniken, the principal center, about 2,000,000 cubic meters of earth are reported to yield about 500 tons of amber, 20 percent of which is fit for ornamental purposes and the rest for lacquer. The sales of cheap imitation amber have been very detrimental to the trade, and in consequence a law was passed in Germany on May 3, 1934, confining the word "amber" to the natural product or to products of molten and cast amber scraps; even the use of such terms as "imitation amber" is illegal. An advertising campaign was begun stressing the superiority of the natural product, and stores displaying the products of the state amber manufactory were opened in several of the larger German cities.[7]

Emerald.—The Government emerald mines of Muzo, Colombia, were operated part of 1934; the value of production was reported as about $238,000. Early in 1934 a Colombian law was passed that required all persons engaged in cutting or selling emeralds to register

[7] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes: Vol. 3, no. 8, Aug. 27, 1934, pp. 5–6.

with the Government. Emeralds found in the possession of unregistered persons are to be confiscated.

Opal.—In the fiscal year ended June 30, 1933, Australia exported unset opals valued at £15,365 (£21,254 in 1931–32), the United Kingdom taking 41 percent, Ceylon 22 percent, Germany 15 percent, and the United States 8 percent. Usually New South Wales is the largest producer, although in 1931 South Australia exceeded it; Queensland also is a minor producer. In 1933 the production of Lightning Ridge, New South Wales, was 4,231 pounds. R. S. Vincent, Minister of Mines, New South Wales, sponsored the idea that the opal be declared Australia's national gem.

Ruby.—Production of rubies in Burma in 1933 is reported to have been only 1,103 carats.

Sapphire.—The use of a fine square-cut Kashmir sapphire in Princess Marina's engagement ring has increased the popularity of sapphires in Great Britain. In 1933 Kashmir produced 1,434,285 carats of sapphire and corundum, the greater part of which must necessarily have been fit only for industrial use. In 1934 about 120 men worked the Anakie sapphire field, Queensland, particularly at Iguana Flat. One fine 886.5-carat stone was found early in the year. In 1933 sapphires sold were valued at £2,826 (1932, £1,982); 1934 sales probably were nearer those of 1932 than 1933. The Minière des Grandes Lacs Africains did not work its sapphire mines in the Eastern Belgian Congo in 1934.

Jadeite.—In 1932 Burma produced 3,026 cwt. of jadeite (2,765 cwt. in 1931), but the reported value was less than half that of 1931. Exports in 1932 were 3,654 cwt.

Madagascar produces many semiprecious stones, the reported production being 52.4 metric tons in 1932 and 131.6 in 1933.

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MINOR NONMETALS: GRAPHITE, GREENSAND, KYANITE, MINERAL WOOL, MONAZITE, OLIVINE, STRONTIUM MINERALS, AND VERMICULITE

By Paul M. Tyler [1]

SUMMARY OUTLINE

GRAPHITE

No annual review of the graphite industry has been published by the Bureau of Mines since 1930. The domestic graphite-mining industry virtually has been in a state of collapse, and for several years world conditions were much depressed. Some improvement was observed in 1933, and in 1934 there were signs of better demand. Excessive stocks that had hung over the American market for several years, intensifying the effects of the depression, seem now to have been largely consumed. European conditions likewise have improved, as the effects of distress sales of Madagascar graphite have worn off and consumption has picked up. Continued growth of the artificial graphite manufacturing industry and the constant threat of overproduction of natural graphite from many present and potential sources engender keen competition, but world-wide revival of demand promised in 1934 to make the struggle for markets more worth while than it had been during the 4 preceding years.

Improvement in the domestic market was reflected chiefly in a marked upturn in imports. However, graphite mining was resumed in several States, although still on a small scale. Attempts were made to revive the Alabama industry, but necessary financial arrangements were not completed during 1934; nevertheless, the Bama Graphite Co., Chilton County, reported small sales at a fairly good price. In California the Black Diamond claims, in a disseminated-schist deposit in the Elizabeth Lake district north of Saugus, Los Angeles County, were taken over under lease on March 30, 1934, by the Western Graphite Co., which installed a flotation plant but did not produce until after the end of the year. This enterprise has been described briefly by Bradley,[2] who notes that the California Graphite

[1] Figures on imports and exports compiled by Claude Galiher, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

[2] Bradley, W. W., Recent Nonmetallic Mineral Development in California: Min. and Met., vol. 16, no. 340, April 1935, p. 182.

Co. entered the same district on February 1, 1935, and was producing foundry facing with a view to supplying high-grade flake later. In 1934 the Crystal Graphite Co., Dillon, Mont., produced a little crystalline graphite which was sold locally. The Carson Black Lead Co., Oakland, Calif., with a mine at Carson, Nev., mined graphite for use in paint; but the Detroit Graphite Co., Detroit, Mich., which produced graphite paint material in 1930, 1931, and 1933, did not operate its L'Anse mine in 1932 or 1934. The Canadian plant of this company across the river at Walkerville, Ontario, was reported sold in 1932. In Washington attention has been given to operating the Okanogan deposits (said to carry 7.7 percent graphite) and another deposit at Blanchard, Skagit County. The $500,000 mill of the Southwestern Graphite Co., Burnett, Tex., was taken over some years ago by new interests, but the plant has remained closed. The Graphite Mines Co., which formerly produced low-grade amorphous graphite for foundry facings from its mine at Cranston (near Providence), R. I., has reported no production for 2 or 3 years.

Artificial graphite is manufactured by the Acheson Graphite Co. at Niagara Falls, N. Y., and several other concerns, including the Stackpole Carbon Co., the Speer Carbon Co., International Graphite & Electrode Co., and Pure Carbon Co., all of St. Marys, Pa., manufacture graphitized electrodes; additional artificial graphite is produced as a byproduct of the manufacture of silicon carbide.

USES

The outstanding feature of the graphite industry in recent years has been the increasing use of amorphous graphite and manufactured graphite and the diminishing use of crystalline varieties, not only relatively but actually. On the basis of 3-year averages the apparent consumption of crystalline graphite in the United States dropped from 18,995 short tons yearly in 1912 to 1914 to 12,642 tons in 1927 to 1929, whereas the use of amorphous and manufactured graphite rose meanwhile from 14,760 to 24,000 tons annually. New uses for amorphous graphite have been developed, and industries that employ this variety of graphite have grown rapidly. Formerly, crucible manufacture was the dominant outlet for graphite, but this use has dropped off as more economical methods of melting steel and nonferrous metals have been developed. Increased demand for high-grade steel instead of enlarging the demand for crucibles hastened the abandonment of the crucible process in favor of electric-furnace or open-hearth methods. Even in the manufacture of plumbago crucibles the highest-priced qualities of Ceylon graphite have been largely supplanted by the cheaper flake graphite from Madagascar, not only in the United States but all over the world.

Opinion has differed considerably as to the actual distribution of sales of natural and manufactured graphite in the United States, due largely to the tendency of individual firms to develop business along specialty lines and general reluctance to reveal to competitors the importance of sales in some of these specialty fields.

Based upon questionnaire returns from 14 of 16 known members of the foundry supplies industry, 9 of 10 known members of the plumbago crucible industry, and 12 of 14 known members of the pencil industry, the total distribution of consumption of natural graphite in 1933 was ascertained by the N. R. A. as follows:

Consumption of natural graphite in the United States in 1933, by uses, in short tons [1]

Use	Flake and crystalline	Amorphous	Total
Foundry facings, core wash, etc.	1,494	2,863	4,357
Paints and pigments	218	772	990
Crucibles, etc.	2,030		2,030
Pencils and crayons	720	678	1,398
Commutator brushes	162	231	393
Stove polish	84	338	422
Lubricants	604	684	1,288
Miscellaneous	402	247	649
Unknown	2		2
	5,716	5,813	11,529

[1] Consumption data compiled by N. R. A. None of the questionnaire returns reported the use or processing for resale of artificial graphite. The consumption of graphite in the paint industry as well as in certain other industries is so scattered that it seemed impracticable to attempt to obtain further detailed information by sending questionnaires to such industries.

During the past several years much attention has been given to colloidal graphite. Lubricants of colloidal graphite of artificial origin have been on the market for many years, but recently it has been found possible to grind natural graphite fine enough, and otherwise process it, so that it will remain suspended in oil for indefinite periods. In the original process for treating mineral oil with artificial graphite, patented by Dr. E. G. Acheson in 1906, the graphite first is suspended in water by the use of deflocculating agents. Extracts of barks, leaves, straw, and other substances were found to have this deflocculating property; in fact, barnyard manure was one of the most effective deflocculants. After standing several days to settle out the sediment, this suspension is filtered and the resulting paste worked with oil to eliminate virtually all the water.

The Joseph Dixon Crucible Co. has obtained rights to patents and patent applications (U. S. Patent 1935344, N. H. Andrews, et al., Impact Pulverizer, and applications 587268 and 633256) covering the process of breaking down natural flake graphite or Ceylon large hard lump to a maximum particle size of about 5 microns. Material ground in this manner expands in bulk so that a container that ordinarily holds 1 pound of graphite will contain only 5 ounces of the "micronized" product. In a letter circular (no. 387, July 25, 1933) the National Bureau of Standards has summarized available information on graphite in lubricants for use either in automobile crankcases or as an upper cylinder lubricant. In general, it would seem that the benefits derived from the use of graphite lubricants are more marked in cars with worn cylinders or engines in poor condition. Of interest in this connection is the following digest of Belgian experience:[3]

Mr. Migurski, an engineer, recently presented a most interesting report on the application of colloidal graphite as a protection of metals against wear. The suspension of graphite in a liquid is possible only if the graphite is in a very finely divided state and if it is introduced into an appropriate liquid—that is, one containing a colloidal stabilizer which prevents flocculation. If the graphite thus placed in suspension comes into contact with a metallic surface there is an attrac-

[3] Industrial and Engineering Chemistry (News Edition), A Graphite Coating Protects Metals and Reduces Costs of Fuel and Lubricants: Vol. 12, no. 20, Oct. 20, 1934, p. 376.

tion between the particles of graphite and the metals to which it clings. When the metal is completely covered, no more attraction is exerted. If the metal is then heated, the graphite adheres to it and resists filing; an abrasive is necessary to remove it. The author in this manner has produced extremely hard and self-lubricating graphite surfaces which do not exceed 0.002 mm in thickness.

Tests upon apparatus lent by railroad companies and various industries have proved that graphite covering of the surfaces gives a coefficient of friction equal to 66 percent of the coefficient of friction with oil. This decrease corresponds to an increase of power and also to an economy of fuel. Thus, referring to tests carried out upon an automobile, Mr. Migurski cites the following results: During the first 4 months, without graphite, the consumption of gasoline was 12.5 liters per 100 km; in the 4 following months, with graphite covering, it was 9.4 liters per 100 km. The consumption of oil dropped from 0.5 to 0.15 liter per 100 km. Likewise, since the viscosity of the oil is of no further significance, and since the oil need not be changed more frequently than every 10,000 km, the cost of lubricants is decreased to the same extent.

The report also cites the resistance of graphite-covered surfaces to chemical corrosion. The author has not been able to observe the slightest trace of attack by sulfuric acid, by hydrochloric acid, or, in general, by any corrosive agents on slabs of different metals coated with graphite.

After the discussion which followed the conference, Mr. Migurski called attention to the fact that tests on the protection against corrosion are in progress in the factories of Ugine, France, with a view to protecting metallic tubes against hydrochloric acid vapors.

The use of graphite containing 25 percent carbon is recommended as a satisfactory yellow coloring agent for glass. High-grade graphite fails to dissolve.[4]

PRICES

The prices of graphite always are difficult to report because a variety of grades are furnished to the ultimate consumers and because so much of the raw graphite purchased by the leading importers is handled under contract at prices arranged by private negotiation between buyer and seller. According to Metal and Mineral Markets the price of Ceylon lump graphite dropped in February 1931 from 7–8½ cents to 6½–8½ cents and during the following month to 6½–7½ cents, where it subsequently remained. The London quotation for Ceylon lump, 90 percent, of average hardness, recently has ranged from £17–19 per long ton, equivalent to 3¾–4¼ cents United States currency, per pound. Allowing for duty, the London price would correspond to a New York quotation of 5–5½ cents per pound. According to Metal and Mineral Markets, the price of Ceylon chip, previously quoted at 6–7 cents per pound, began to soften even in 1929 and dropped in 1931 to 5–6 cents per pound, after which there was no further change. Ceylon dust, according to the same authority, began to decline in August 1930 and dropped to a minimum of 2–3 cents, which quotation was revised upward in July 1931 to 3–4 cents per pound.

For raw Madagascar flake, 85–90 percent carbon, the New York quotation of 6–8 cents in 1929 remained substantially unchanged until February 1931 when it began to sag, reaching 4–6 cents in the second quarter of that year; however, the price increased to 5–6 cents in July and subsequently remained at this level. The London price recently has been quoted at £16–18 which, allowing a margin of 1¾ cents per pound to cover duty and miscellaneous charges, would be equivalent to a New York price of 5½–5¾ cents per pound.

Amorphous graphite has recently been quoted in Chemical Industries at 3–4 cents per pound.

[4] Chemical Industries, Coloring Glass with Graphite: Vol. 34, no. 5, May 1934, p. 419.

Prepared flake graphite is quoted variously at 8–16 cents per pound; however, these prices probably do not apply to large contract business. It has recently been stated that flake graphite for the battery trade is worth 5 or more cents a pound. Pencil graphite generally ranges from 6–8 cents per pound, depending upon its quality and the degree of preparation, although, of course, some special materials may sell up to 15 or more cents per pound. Foundry-facing graphite of flake origin may be worth $50 a ton, with other qualities selling at various discounts according to their nature. In 1928 Madagascar graphite rose to 1,600 francs per metric ton, f. o. b. Tamatave, but by the end of 1929 first-choice large-flake graphite was selling at 1,500 francs and small-flake, unsuitable to the American market, was being shipped to Germany at a price of approximately 1,250 francs or $48.90. In 1931, a few sales were made to the United States at prices ranging from $66 per ton c. i. f. for inferior grades to $85 and $90 for large-flake of 87- and 90-percent carbon content, respectively. On the other hand, the quotation on the Marseilles exchange in that year was only 1,100 francs per metric ton, equivalent to $43.04. In 1934, however, the average foreign market value of direct shipments from Madagascar to the United States, as reported in the American import statistics, was 3.9 cents per pound compared with about 4.5 cents for shipments from Europe and Canada and an average of 4.2 cents per pound for all imports of flake graphite. Sales of domestic graphite were made in tonnage quantities at 7 cents per pound and small lots at higher prices. Amorphous graphite of domestic origin is nominally around $10 a ton.

FOREIGN TRADE

Imports.—Partly because of active demand and partly in anticipation of possible upward tariff changes imports of graphite into the United States in 1929 rose to a post-war maximum of 24,072 short tons valued at $1,066,834. Even during 1930 they amounted to 16,726 tons valued at $624,668, most of which entered during the early months before the Tariff Act of 1930 which raised the duty on crystalline, lump, chip, and dust from 20 to 30 percent of the foreign market value and that on crystalline flake from 1.5 to 1.65 cents a pound, leaving amorphous unchanged at 10 percent ad valorem. In 1932 imports dwindled to 7,015 tons valued at $150,791, the low point of the depression. After a moderate increase in 1933 they jumped to 14,121 tons valued at $489,484 in 1934. During the 5-year period 1909–13 imports of graphite averaged 24,345 short tons valued at $1,808,383. The distribution of imports for consumption according to kinds reveals increases under all classifications except artificial graphite.

The table of imports by countries brings out the declining importance of Ceylon. The comparison would be even more striking if the figures could be given in terms of American valuation, as the tonnage has been bolstered by relatively larger shipments of dust and amorphous grades. Ceylon supplied only 26 percent of the aggregate tonnage of graphite imported into the United States in 1934 compared with an average of 33 percent during the 5-year period 1925–29; prior to 1914 well over 60 percent of the tonnage and 80 percent of the value of the foreign graphite used in this country came from Ceylon.

Mexico and to some extent, Chosen, have increased their tonnage contributions but are getting much less for it now than before the World War. Canada, on the other hand, has been furnishing a somewhat smaller quantity but receiving in the aggregate about as much for it. In fact, from 1925 to 1929 the value of the annual imports from Canada was actually greater, whereas the quantity was considerably less than before the war. As Madagascar had scarcely begun production in 1913, no imports from that colony appeared in the prewar statistics.

Graphite imported for consumption in the United States, 1931–34, by kinds

	1931		1932		1933		1934	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Amorphous:								
Artificial	639	$29,071	656	$23,315	711	$27,107	579	$22,591
Natural	6,409	119,345	5,275	71,970	5,999	90,786	10,469	235,592
Crystalline:								
Lump and chip	822	32,823	187	6,227	294	9,532	384	18,878
Dust	78	4,534	107	4,042	90	3,072	302	12,109
Flake	1,142	73,986	790	45,237	959	80,569	2,387	200,314
	9,090	259,759	7,015	150,791	8,053	211,066	14,121	489,484

Graphite (all kinds) imported into the United States, 1925–34, by countries [1]

Country	1925–29 (average)		1930	1931	1932	1933	1934	
	Short tons		*Short tons*	*Short tons*	*Short tons*	*Short tons*	*Short tons*	
Canada	1,876	$108,599	2,219	956	828	946	1,814	$74,750
Ceylon, including British India	6,261	415,051	4,056	2,825	1,756	2,050	3,741	166,528
Chosen, including Japan	1,270	22,144	1,173	624	1,314	1,542	1,950	21,397
Germany	46	4,710	27	69	94	121	368	28,875
Italy	203	5,439	132	-------	25	135	-------	-------
Madagascar, including France	2,484	240,840	2,638	1,093	788	885	2,014	159,654
Mexico	6,290	51,694	6,460	3,523	2,203	2,332	4,162	33,306
Norway	3	459	-------	-------	-------	-------	72	4,743
U. S. S. R. (Russia)	(2)	9	-------	-------	-------	41	-------	-------
United Kingdom	136	15,260	2	(2)	7	1	(2)	231
Other	72	5,263	19	-------	-------	-------	-------	-------
	18,641	869,468	16,726	9,090	7,015	8,053	14,121	489,484

[1] Data on total imports during 1934 may not be strictly comparable with figures for previous years due to the change in the system of reporting imports made by the Bureau of Foreign and Domestic Commerce beginning January 1934. For 1933 and earlier years the figures represent "general imports" and cover goods imported for immediate consumption plus goods entering the country under bond, whereas totals for 1934 represent "imports for consumption" and include goods imported for immediate consumption plus withdrawals from bonded warehouses.

[2] Less than 1 ton.

Exports.—Under normal conditions substantial quantities of graphite are exported annually from the United States. Of these exports, considerable material has been reported as consisting of "unmanufactured" graphite, but, actually, much of this has comprised specially processed material for pencil making. Graphitized electrodes, both electric-furnace and battery, also are shipped abroad. Natural graphite of foreign origin enters into the manufacture of various products, but domestic exporters have not troubled generally to apply for drawbacks or refund of duties paid on the imported material used.

Graphite exported from the United States, 1927–34

Year	Short tons	Value	Year	Short tons	Value
1927–29 (average) [1]	1,878	$420,260	1932 [2]	790	$173,486
1930 [1]	1,556	418,430	1933 [2]	914	182,671
1931 [1]	1,188	248,998	1934 [2]	1,245	250,332

[1] Graphite and manufactures, except crucibles.
[2] Graphite, crude, refined, and manufactures (including crucibles).

THE INDUSTRY IN FOREIGN COUNTRIES

Czechoslovakia for several years produced more natural graphite than any other country, but its output, consisting mostly of the low-grade product from the Bohemian deposits, reached a maximum in 1927, collapsed late in 1930, and subsequently has dwindled to virtually insignificant proportions. On the other hand, in the nearby Bavarian district of Passau over the German border production continued to increase and was well maintained even after 1930, without any serious set-back until 1934. Austrian production rose rapidly to a peak of 25,296 metric tons in 1929 and later declined only about 50 percent; a large part of the product is exported to Germany.

World production of natural graphite, 1925–33, in metric tons

[Compiled by M. T. Latus, of the Bureau of Mines]

Country	1925–29 (average)	1930	1931	1932	1933
Australia:					
New South Wales	12		61		30
South Australia				70	
Austria	19,083	17,689	12,060	10,598	14,771
Brazil [1]	4	10	9		1
Canada	1,756	1,393	497	314	367
Ceylon [1]	13,618	8,891	6,828	6,198	9,711
Chosen [1]	18,484	33,850	14,050	16,733	22,677
Czechoslovakia	29,276	14,560	1,830	922	122
France	734	230		(2)	(2)
Germany (Bavaria)	17,548	24,996	23,571	20,808	13,750
India, British	8		7	5	
Indo-China [3]	289				
Italy	8,487	5,880	4,050	2,945	3,200
Japan	578	230	295	495	869
Madagascar [1]	14,141	9,200	6,300	2,100	6,795
Mexico	5,699	5,853	3,122	2,045	2,685
Morocco, French [1]	21	140	50	100	66
Norway			882	672	1,983
Spain	580				
Union of South Africa	51	51	44	49	59
United States:					
Amorphous	2,840	1,761	(4)	(4)	(4)
Crystalline	2,133	(4)	(4)	(4)	(4)
U. S. S. R. (Russia)	3,992	(2)	(2)	(2)	(2)

[1] Exports.
[2] Data not available.
[3] Concentrates.
[4] Bureau of Mines not at liberty to publish figures.

Most of the graphite from these Central European countries, together with that from Italy, which is likewise a fairly large producer, is suitable only for local use and, except for over-the-border shipments, does not enter extensively into international trade. Madagascar, Ceylon, Chosen, and Mexico supply the bulk of the natural graphite that is valuable enough to bear the cost of shipment overseas or long distances by rail. The leading graphite-consuming countries, roughly in order of importance in the output of finished products made from high-grade graphite, are Germany, the United States, Great Britain, and France.

The following brief review relates to developments in specified countries since the last Bureau of Mines report for the year 1930.

British Africa.—Small but fairly regular outputs of graphite have been reported from British South Africa for a number of years. No graphite has been produced in the Rhodesias, but in Northern Rhodesia a band of graphite-bearing schists averaging about 21 percent flake graphite recently has been found. Development work was carried out on this deposit by Loangwa concessions (Northern Rhodesia, Ltd.), with prospects of profitable exploitation. Nyasaland flake graphite of excellent quality is reported[5] in Angoniland and has been worked on a small scale both in Nyasaland and in the adjacent Portuguese territory between Ncheu and Mlangeni. Samples of coarse flake graphite from near Mkhoma Mission, central Angoniland, were found by the Imperial Institute to equal the best grades of Ceylon graphite. Similar graphite occurs along the Njovualema Stream, near Nzama, Ncheu district. Graphite schists are known also at several localities in the Port Herald Hills.

Canada.—In recent years the Black Donald mine, Calabogie, Renfrew County, Ontario, has been the only producer of graphite in Canada. A number of years ago deposits and mills situated in Bancroft and Perth districts in Ontario and in the Buckingham, Guenette, and St. Remie districts in Quebec were fairly active, producing flake graphite for the crucible trade, but all these plants had to discontinue because of excessive costs. The Black Donald mine is in one of the largest known graphite deposits in the world, and in 1929 it employed 60 men and produced 1,288 short tons, chiefly small-size flake graphite classed as "amorphous." This property was forced to close in September 1931 but subsequently was reopened. The Canadian output in 1933 was 405 tons valued at $18,367, an advance of over 15 percent in tonnage but a slight reduction in value compared with the 1932 output. The value of the production for 1934 was reported as $71,424, indicating a strong revival, but tonnage figures are not available. The exports, evidently partly from stock, were 1,935 tons valued at $90,129 in 1934 compared with 987 tons valued at only $40,115 in 1933. According to a recent note,[6] Canadian graphite has been used for the first time in history for making lead pencils as a result of a patented process perfected by the Dixon Pencil Co., Ltd., of New Market, Ontario.

Ceylon.—Ceylon graphite, long supreme in world markets, has been displaced in recent years largely by Madagascar flake graphite for various purposes, including the manufacture of crucibles. In its heyday the Ceylon industry afforded employment to as many as 50,000 persons and exported 30,000 tons or more of graphite a year, chiefly high-grade qualities. Early in 1929 the number of graphite mines in operation was 281, whereas in October 1930 only 2 mines still were being worked. In 1931 the total Ceylon output dropped to 210 tons valued at only Rs. 110 per ton. Competition diminished the average

[5] South African Mining and Engineering Journal, The Mineral Resources of Nyasaland. Graphite: Vol. 44, no. 2168, Jan. 27, 1934, p. 391.

[6] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes, Canadian Graphite Used for Pencils: Vol. 4, no. 1, Jan. 27, 1934, p. 2.

value as well as the total value of exports of graphite from Ceylon. This reduction is due partly to lower prices received for standard grades of Ceylon lump and chip but more especially to a relative increase in the quantities of "amorphous" graphite which, of course, sells at only a fraction of the prices obtainable for the higher qualities of vein graphite. In 1932 the average price per ton of exports was Rs. 176.73 compared with Rs. 182.34 in 1931 and Rs. 203.50 in 1930. Late in 1930 dealers and shippers of graphite in Ceylon combined to form a buying pool and fixed prices on all grades of graphite. Cooperative efforts have been made from time to time to combat claims that Madagascar flake is superior to Ceylon vein graphite for the manufacture of crucibles, and Ceylon Government officials have also sought to improve the state of the industry. Formerly, the United States was the largest purchaser of Ceylon graphite, frequently taking 50 percent of the total output, and the rest was consumed principally by Germany and Great Britain. Lately, however, Japan has become the main outlet; the Ceylon plumbago is said to be used chiefly for foundry purposes, whereas Chosen and perhaps Madagascar graphites are said to be employed in Japan for lead-pencil manufacture. In 1933 Japan was again the biggest buyer of Ceylon plumbago, taking (of a total of 9,558 long tons) 3,581 tons valued at Rs. 454,852, compared with 2,211 tons valued at Rs. 278,739 shipped to the United States and 841 long tons to Germany. Graphite exports from Ceylon during 1934 increased to 11,569 tons, of which Japan purchased 3,925 tons and the United States 3,354 tons.

Chosen.—Chosen is one of the very few countries which succeeded in maintaining production of graphite at a normal rate after 1929. The output in 1933, for example, was within 1 percent of the 1929 record. Japan is naturally the principal buyer of Chosen graphite, but substantial quantities are exported to other countries, including China and the United States. Notwithstanding the fact that the output consists almost exclusively of amorphous grade it finds a world market. Total exports of graphite from Chosen in 1933 were 26,801 short tons (compared with 18,278 tons in 1932), of which flake graphite constituted only 1,902 tons (999 tons in 1932), the balance being amorphous.

Germany.—Early in 1933 German graphite producers consummated a merger to improve the position of the industry from both commercial and technical standpoints, and active efforts have been made to make the country independent of imported supplies. The new organization is known as the "Graphitwerke Kropfmuhl A. G." of Munich; it is said to be owned largely by the Krupp company and the Bayerische Hypotheken u. Wechselbank. Other companies involved in the merger are Vereinigte Graphit u. Tiegel Werke at Obernzell and Deutsche Graphitgesellschaft m. b. H. at Untergriesbach. Passau graphite has been exported recently to Great Britain, and during the last 2 or 3 years increasing shipments have been made to the United States. Slight increases in imports, following the sharp reduction in 1929–32, were not due to larger receipts from Ceylon or Madagascar but to importations from Austria, probably from plants affiliated with the German interests. Active efforts still are in progress to expand the applications of Passau graphite to all purposes for which the more costly Ceylon or Madagascar graphites formerly have been employed.

Italy.—Before the World War Italy was the third largest producer of graphite, but subsequently it dropped to seventh or eighth place following the breaking up of the Austro-Hungarian Empire and new developments in Chosen and Madagascar. Production originates principally in western Piedmont, the leading producer being the Societa Anonima Talco e Grafite Bal Chisone at Pinerolo (Torino). Local natural graphite is being employed in Italy in the manufacture of electrodes which are reported to be 15 to 20 percent cheaper than graphitized electrodes (artificial graphite).[7]

Madagascar.—In 1917 the output of graphite in Madagascar reached 35,000 tons, and the industry employed several thousand white men and 200,000 natives. Even under war-time conditions, world markets failed to absorb this huge quantity promptly, and the industry languished for several years until surplus stocks were disposed of. Beginning in 1922 the Madagascar Government refused to issue export licenses for graphite containing under 85 percent carbon, thereby reducing sales resistance on the product in various countries and contributing to a fairly steady increase in exports, which rose from 6,675 metric tons in 1922 to a maximum of 16,049 tons in 1929. Even in 1929 there was a slight overproduction, and after the depression began mine output was not reduced to correspond to the reduced flow of exports. Mining virtually had ceased in the autumn of 1930, and despite a substantial revival of exports there was no occasion for reopening the mines until well into 1934. The nadir of the Madagascar industry was reached in 1932 when shipments of graphite from the island fell to 2,150 tons.

Probably the largest producer of graphite in Madagascar is the Société des Graphites de la Sahanavo, but after a consolidation early in 1931 the Union des Graphites has become of almost equal importance. Other normally large producers are the Compagnie Lyonnaise de Madagascar, the Compagnie Generale de Madagascar, the Compagnie Coloniale de Madagascar, and Abel Louys. The Masker Co. affiliated with the Morgan Crucible Co. of London, is a large factor in the Madagascar trade and usually is the principal cash buyer of graphite produced by the smaller companies.

Mexico.—The production of graphite in Mexico is confined to high-grade amorphous graphite produced in southern Sonora. Virtually all of the output from this area has been shipped to the United States, although efforts have been made to develop markets in other countries, including Japan. The Mexican industry reflected the world depression, and during 1932 the mines controlled by the principal producing interest were idle except for maintenance work, and two of the smaller mines were operated merely to keep them open. In 1934 shipments from Sonora to the United States were 3,918 tons compared with 2,937 tons in 1933; in 1932, the low point, exports were only 1,990 tons compared with a maximum of over 8,500 tons in 1929. Nearly half the 1934 shipments were made during the fourth quarter, and operations were being expanded in anticipation of further increases in demand.

Norway.—The Norwegian production, never very large, recently has been supplied by the A/S Skaland Graftiwerk and a smaller under-

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[7] Giolitti, F., Savings Due to Electrodes of Natural Graphite: Metal Progress, vol. 21, March 1932, pp. 68–69: Metals and Alloys, vol. 4, no. 3, March 1933, p. MA81.

taking to the north. A brief description of the Skaland graphite mine and washer has appeared recently.[8]

Spanish Morocco (*Gomara*).—Graphite occurs over a considerable area in Gomara west of the Riff, sometimes in pockets but more often in a series of small lenses following a vein of limonite and quartz enclosed in serpentine and ranging in width from 20 to 70 cm. The carbon content of the raw graphite ranges from 37 to 65 percent and, in pockets, frequently up to 90 percent. No difficulty is anticipated in preparing a marketable product of flake graphite containing a minimum of 90 percent carbon. These Moroccan deposits, situated near one of the main maritime trade routes of the world, are deemed to be of potential importance commercially.

U. S. S. R. (*Russia*).—One of the most famous graphite deposits in the world was the Alibert mine near Irkutsk, eastern Siberia, which was worked for many years primarily as a source of pencil graphite, most of it being exported to the German Faber Pencil Co. Graphite has been reported in various localities, both in Asiatic Russia and in the Ukraine, and soviet geologists have made numerous new discoveries during the past several years. A good deal of attention has been given to the possibility of flotation and other methods of beneficiating the lower-grade material. The leading development is situated in the Turukhansk region of northern Siberia, whence came most of the prewar output. Some of the new deposits discovered in this region are located near a refining plant which has been completed on the bank of the Yenisei River, which is navigable for a brief period during the summer when not closed by ice. Part of the Siberian graphite is lump graphite resembling the vein graphite from Ceylon, but most of it is amorphous; it is used mainly for pencils, lubricants, paints, and foundry facings.

Deposits in the Urals, in the general vicinity of the Alibert mine, also have been operating for several years, and in 1934 a new graphite plant was reported[9] to have begun operation in the Gruzhkov region near Odessa. The plant will have an output of 4,000 tons of graphite products annually for supplying metallurgical plants, pencil factories, and the printing industry. The two existing graphite factories in the U. S. S. R., at Kyshym in the Urals and at Mariupol, have capacities of 3,000 and 700 tons a year, respectively. Although the older factories are a considerable distance from the source of raw materials, the new factory is constructed right at the mine, which is said to be capable of furnishing 120,000 tons of "graphite ore" a year. The completion of this plant is expected to relieve the U. S. S. R. from the necessity of further imports.

GREENSAND (MARL)

Enormous deposits of greensand lie unexploited in New Jersey and various other States, and substantial sums have been spent in efforts to convert them into commercial assets. Originally used extensively as fertilizer, greensand was produced in steadily diminishing quantities until its growing use in water softeners brought about a revival. This revival, however, has altered the nature of the demand so that the industry no longer furnishes a heavy tonnage of cheap material;

[8] De Ingenieur, De grafiet-mijn en wasserij te Skaland (Noorwegen): Vol. 49, no. 10, The Hague, 1934, pp: M21–22.

[9] Economic Review of the Soviet Union, vol. 9, no. 5, May 1934, p. 122.

it now supplies a quality product of high unit value but in rather small quantities. In 1877, for example, New Jersey greensand was selling f. o. b. pits for 60 cents a ton. In 1901, after a brief recovery from a long relapse, the domestic output, including a small quantity from Virginia, was 99,980 tons, valued at $124,880 ($1.25 a ton). By 1908, however, another slump reduced production to only 8,246 tons valued at a trifle over 40 cents a ton, and for 1913, the pre-war base year, the record shows only 314 tons, worth $223 or 71 cents a ton. Even the war-time shortage of potash failed to raise the price above $1.50, and the maximum output during this period was 3,582 tons in 1918. The demand for water softeners boosted production in 1922 to 7,885 tons, having a value of $56,800 or more than $7 a ton, and a still larger tonnage mined in 1923 was valued by producers at over $12 a ton. Later statistics are shown in the following table.

Greensand produced in New Jersey, 1925–34

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per ton			Total	Average per ton
1925–29 (average)	12,515	$195,393	$15.61	1932	9,231	$201,173	$21.79
1930	12,761	221,211	17.33	1933	6,713	206,985	30.83
1931	8,252	196,327	23.79	1934	7,335	209,278	28.53

Since 1930 the best grade of greensand, screened and bagged, has been quoted in Metal and Mineral Markets at $20 per short ton, f. o. b. cars in New Jersey, in carload quantities.

Several years ago the Texas Agricultural Experiment Station reported that the greensand of that State did not contain enough fertilizing material to justify attempts to sell it as a commercial fertilizer, and developments in the potash situation during the last several years have silenced most of the discussion of methods for recovering the fertilizer constituents of New Jersey greensand in the form of concentrated salts. However, a somewhat different approach to the problem of recovering the acid-soluble elements is shown by three fairly recent patents,[10] and still another patent (U. S. Patent 1839982) covers the use of glauconite as a flux or binder for basic dolomite refractories. Another field for utilizing glauconite is disclosed by Turrentine's patent (U. S. Patent 1932832, Oct. 31, 1933) for utilizing the adsorbent silica residue after dissolving out the acid-soluble elements. Further research has been in progress with a view to utilizing Maryland greensand as a decolorizing agent for the same general purposes as fuller's earth. Ground raw, it affords a suitable bleach for cotton oil and after an incomplete acid treatment may be used for refining mineral lubricating oils. Although less efficient for the latter purpose than acid-treated bentonites, it has possibilities because of its much lower cost. A brief reference to some of this work [11] was published 2 years ago, but commercial

[10] Lambert, Arthur (to Cosmic Arts, Inc.), Treating Greensand Or the Like to Produce Various Salts: U. S. Patent 1924503, Aug. 29, 1933.
——— Treatment of Greensand: U. S. Patent 1797002, March 17, 1931. McWhorter, P. K., Jr., Treatment of Minerals (Greensand) Containing Compounds of Iron, Potassium, and Aluminum. U. S. Patent 1843779, Feb. 2, 1932.
[11] Nutting, P. G., The Bleaching Clays: U. S. Geol. Survey Circ. 3, 1933, pp. 11, 46.

operations have not begun. Recently glauconite deposits and their possible utilization in Australia have been described.[12]

KYANITE

A century and a half ago Saussure experimented with kyanite, and subsequently other minerals of the sillimanite group claimed attention of mineralogists from time to time, but apparently none of them was utilized practically until about 1920. Bleininger and Riddle's work at the National Bureau of Standards on spark-plug porcelain during the World War stimulated a search for natural sources of these monosilicates of alumina which resulted in discoveries of andalusite in California, dumortierite in Nevada, and kyanite in North Carolina, California, Virginia, Wyoming, and other States. A few small outcrops of sillimanite have been found in this country, notably in South Dakota, but not in commercial quantities. Prehistoric implements of compact sillimanite are found in western Europe, but commercial deposits of this mineral have not been found on the Continent. In 1921, however, it was identified as a constituent of corundum shipped from the Khasi Hills, British India. Mullite, synthesized as long ago as 1865 by Sainte-Claire Deville and Caron, actually occurs native on the Isle of Mull [13] but only as tiny crystals embedded in glassy rocks (buchites). It may be found in other localities where sillimanite or kyanite occurs in contact rocks that were strongly heated, but typically it is an artificial substance produced either synthetically or by heating minerals of the sillimanite group, all of which are converted into mullite at temperatures around 1,310–1,350° C. (cone 12–13).

Statistics of production and imports of kyanite, sillimanite, andalusite, and dumortierite in the United States are available only for California, and even the California figures are not available annually. Leading producers are the Champion Spark Plug Co. of Detroit, Mich., which has mined dumortierite and andalusite, respectively, in Nevada and California for 10 years or more; the Vitrefrax Co. of Los Angeles, Calif., which produces kyanite from a large deposit in Imperial County, Calif., and manufactures sundry ceramic products; the Industrial Minerals Corporation (formerly Hoyt Mineral Co.), Franklin, N. C., which has made substantial shipments of kyanite (mostly massive kyanite from pegmatite lenses) from North Carolina and Georgia; and Celo Mines, Inc., Burnsville, N. C., which produces high-grade concentrates from disseminated deposits. The McLanahan & Watkins Co., Charlotte Court House, Va., was a pioneer in the field of mechanical concentration of kyanite, but this operation has been rather inactive for several years. Field work in the summer of 1934 by the United States Geological Survey in cooperation with the Geological Survey of Georgia and the United States Bureau of Mines, under funds granted by the Public Works Administration, resulted in the discovery of a belt of kyanite schist 30 miles long that contains large reserves of kyanite.[14] Preliminary tests showed that the material could be concentrated readily into a high-grade product with an average yield of at least 1 ton of concentrates per 25 tons mined.

[12] Simpson, Edward S., Glauconite: Chem. Eng. and Min. Rev., vol. 26, no. 310, July 5, 1934, pp. 391–394.
[13] Bowen, N. L., Greig, J. W., and Zies, E. G., Mullite, a Silicate of Alumina: Jour. Wash. Acad. Sci., vol. 14, no. 9, Apr. 19, 1924, pp. 186–187.
[14] Prindle, L. M., and others, Kyanite and Vermiculite Deposits of Georgia: Geol. Surv. of Georgia Bull. 46, 1935, 50 pp.

Placer deposits 2 or 3 feet thick also occur in Georgia, and small production of fairly pure crystals has been obtained by shoveling this material into an ordinary sluice.

Apparently the only foreign producer of kyanite-group minerals is British India. Since the Khasia Mines, Ltd., was liquidated in 1922 and stocks of sillimanite-corundum rock then on hand in London were sold, the only real production in India has been by the Indian Copper Corporation from Lopsa Hill in Kharsawan (about 175 miles west of Calcutta), which has shipped kyanite to England, the United States, Germany, Belgium, and Italy. The output in 1926 was approximately 2,000 long tons valued at Rs. 36 per ton f. o. b. Amda, a station on the Bengal-Nagpur Railway. In 1932 an output of 5,580 tons was reported officially, and in 1933 the output declined to 4,283 tons valued at £5,220. Except for 3 tons produced in Ajmer-Merwana, Rajputana, in 1932 and 17 tons in Mysore State in 1933 the recent output has come from the Singhbhum district in Bihar and Orissa (Lopsa Buru mine). Reserves of sillimanite are estimated at more than 200,000 tons, but the known deposits, in the Khasi Hills and at Pipra (Rewa), are overwhelmingly handicapped with respect to transportation costs and are not expected to be available commercially, at least for many years. Kyanite reserves of some consequence are reported in several localities in northern India, and the Lopsa Hill deposit has been credited with reserves of the order of hundreds of thousands of tons. Field studies of deposits in Assam, Rewa (central India), Bhandara (Central Provinces), Singhbhum and Manbhum (Bihar and Orissa), have been described in an official report.[15]

There is no reason to believe that natural occurrences of kyanite are limited to the United States and India, but even if this were true supplies would be abundant enough to meet any reasonable demand for years to come. Commercial developments are restricted only by demand, and although they have not kept pace with the optimistic expectations voiced in many quarters before 1929, steady advances have been made during the depression years.

Sillimanite and andalusite undergo no appreciable change in volume when they are converted into mullite by heat. This is an advantage in many high-grade ceramic products, as it tends to result in a better bond of interlocking crystals in the fired body. Kyanite, on the other hand, expands considerably when this molecular rearrangement occurs, and the expansion is principally on the long axis of the crystal. Kyanite after precalcining (not an excessively costly process), may be used in fine ceramic ware, but the calcined material is rather friable and more difficult to bond than raw sillimanite or andalusite. In the production of high-alumina refractories, the expansion of kyanite, instead of being undesirable, may be an advantage, as it may be used to neutralize shrinkage. Some ceramic engineers feel that therein lies an opportunity for extensive commercial developments. Moreover, it is claimed that fairly high percentages of uncalcined kyanite may be used in refractory bodies without distorting on firing, provided the kyanite is ground fine enough. It appears that when the uncalcined kyanite is introduced in a very finely divided state a much better interlocking of crystals is obtained and a better bonded condition also results.

[15] Dunn, J. A., Aluminous Refractory Materials: Kyanite, Sillimanite, and Corundum in Northern India: Memoirs Geol. Surv. India, vol. 52, no. 2, 1929, pp. 145–274.

The marketing of kyanite is still very much in the development stage. At present, leading uses are for special refractories, particularly glassworks refractories, including "sillimanite" brick. Kyanite has definite advantages in the manufacture of electrical porcelain, both as a batch constituent of the porcelain itself and as a mechanical bonding agent in the saggers; it increases mechanical and dielectric strength. In addition to its use in spark-plug cores and electrical porcelain, kyanite has a substantial and growing use as an addition to chemical ware, and it is employed to some extent in sanitary and hotel ware. Consideration is being given to the use of kyanite extensively as a raw material for glass making. It is far too expensive to compete with other materials simply as a source of alumina, but it does toughen the product and accordingly has been advocated for all kinds of glass, including window, plate, bottle, and table glass. Watkins [16] lists the refractory uses of kyanite and allied minerals as follows: Glasshouse refractories, crucible furnaces, brass-melting furnaces, electric furnaces, forging furnaces, tunnel-car tops, saggers, high-temperature cements, monolithic construction, oil- and gas-fired fire boxes, combustion tunnels, boiler furnaces, and cement-kiln linings.

When first introduced, over 10 years ago, kyanite cost $100 or more a ton, but this price was soon reduced to $40 and later dropped steadily although more slowly. According to Riddle,[17] "Cost is the limiting factor in the almost universal use of sillimanite wherever fire clay, silica, high alumina, or kaolin brick are used." At the end of 1934 Celo Mines, Inc., was quoting its raw concentrates (through 20- plus 60-mesh), f. o. b. Burnsville, N. C., on a sliding scale beginning at $18 a short ton for 70- to 80-percent kyanite and reaching $25 a ton for 90 or more percent kyanite. A differential of $15 a ton was charged for calcining. Freight rate to various Ohio points and Baltimore was $5.50 per 2,000 pounds and to Pittsburgh $5.75. Imported material is even cheaper and is higher in alumina (possibly because of a corundum content).

MINERAL WOOL

The term "mineral wool", originally applied to a very specialized product used for high-temperature insulation, has come to include both rock wool and slag wool. These products are finding an increasing number of uses in industry and transportation as well as in construction, but by far the main outlet is for insulating residences to make them warmer in winter and cooler in summer. Unlike many building materials, it is in demand not only for new construction but also for modernizing homes already built. With the fast-growing demand for air conditioning, mineral wool occupies a favorable position among the various fireproof materials on the market; it is serviceable and relatively cheap in most localities.

Mineral wool is by no means a new product, but production statistics published during the first decade of the twentieth century show an almost imperceptible growth for the industry in its early stages. In 1911, for example, the output in the United States was only 7,514 short tons valued at $65,500 ($8.72 a ton). About one-third of this

[16] Watkins, Joel H., Economic Aspects of Kyanite: Kyanite in Virginia: Virginia Geol. Surv. Bull. 38, 1932, p. 44.

[17] Riddle, F. H., Minerals of the Sillimanite Group: Eng. and Min. Jour., vol. 133, no. 3, March 1932, pp. 141–142.

quantity was slag wool. The material at that time was used mainly in manufactures, although some was packed into hollow walls of cold-storage buildings and refrigerators of various types. Slag wool has been made for over 50 years, and rock wool was made in Indiana as early as 1897.

The magnitude of the manufacturing industry at present is revealed by the organization of the National Association of Rock and Slag Wool Industries, which claimed to represent 95 percent of the manufacturers and submitted a proposed code of fair competition to the N. R. A. at a public hearing January 30, 1934. P. A. Andrews, 22 East Fortieth Street, New York, N. Y., was named chairman of the Code Authority, and the budget (0.5 percent) recommended for the second half of the year was based on gross sales of $1,686,634.80 during the first 6 months of 1934.

In this industry 80 percent of the output is made by manufacturers whose principal business is the manufacture of other products, but the list of members comprises the following 29 names:

Alton Mineral Wool Co., P. O. Box 268, Alton, Ill.
Aurora Insulating Products Co., 2 Park Avenue, New York, N. Y.
The Celotex Co., 919 North Michigan Avenue, Chicago, Ill.
Coast Insulating Co., 634 South Western Avenue, Los Angeles, Calif.
Columbia Mineral Wool Co., 9 South Clinton Street, Chicago, Ill.
The Eagle-Picher Lead Co., Temple Bar Building, Court and Main Streets, Cincinnati, Ohio.
General Insulating & Mfg. Co., Alexandria, Ind.
Forty-Eight Insulations, Inc., Aurora, Ill.
Indiana State Farm, R. F. D. 2, Greencastle, Ind.
Insulating Products Co., Aurora, Ill.
Johns-Manville Sales Corporation, 22 East Fortieth Street, New York, N. Y.
The Mineral Felt Co., Toledo, Ohio.
Owens-Illinois Glass Co., Toledo, Ohio.
The C. W. Poe Co., 2795 East Eighty-third Street, Cleveland, Ohio.
Refractory & Engineering Corporation, 1500 South Western Avenue, Chicago, Ill.
Rock Wool Products Co., Wabash, Ind.
St. Louis Fire Brick & Clay Co., 3050 East Slausen Avenue, Huntington Park, Calif.
Salem Lime & Stone Co., Salem, Ind.
Seneca Rock Wool Co., c/o Heilmann Bros., Tiffin, Ohio.
The Standard Lime & Stone Co., 2004 First National Bank Building, Baltimore, Md.
Standard Rock Wool, Inc., Yorktown, Ind.
Tennessee Products Corporation, 14 Cummins Station, Nashville, Tenn.
The Therminsul Corporation of America, 1603 Fulford Street, Kalamazoo, Mich.
Union Fibre Co., Inc., Winona, Minn.
United States Gypsum Co., 300 West Adams Street, Chicago, Ill.
United States Mineral Wool Co., 280 Madison Avenue, New York, N. Y.
Weber Insulation Products Co., 5543 Alba Street, Los Angeles, Calif.
Weber Insulations, Inc., East Chicago, Ind.
White Bros. Smelting Corporation, Bridesburg-on-the-Delaware, Philadelphia, Pa.

The Bureau of the Census reported figures on value of "mineral-wool products" manufactured in the United States based upon its canvass of asbestos-products manufacturers. In 1929, 8 establishments—2 in Indiana and 1 each in California, Illinois, Michigan, New Jersey, Ohio, and Wisconsin—reported a total output of rock- and slag-wool products valued at $2,377,324. Production in 1931 was valued at $2,873,230, and a preliminary figure of $1,714,171 for 1933 was described as "incomplete."

Since 1918 the Bureau of Mines has published the quantities of limestone reported by producers as used in making mineral wool. No data are available with respect to consumption of slag, and substantial quantities of rock wool are likely never to be reported in this category; nevertheless, the tonnage reported probably represents a good enough sample of the industry to afford an index to recent growth. The figures in the following table show a strong upturn in 1928 and a well-sustained output after 1929, when demand for other building materials was at low ebb.

Limestone used for rock wool in the United States, 1919–33 [1]

Year	Short tons	Value	Year	Short tons	Value
1919	12,500	$17,164	1927	15,390	$12,962
1920	21,570	24,773	1928	31,700	27,042
1921	(2)	(2)	1929	83,920	92,092
1922	9,170	10,622	1930	64,850	70,988
1923	6,940	9,333	1931	73,640	67,393
1924	7,530	14,808	1932	43,180	38,321
1925	12,660	14,308	1933	55,160	42,305
1926	18,880	19,448			

1 From reports of limestone producers to Bureau of Mines.
2 Bureau of Mines not at liberty to publish figures.

In 1934 the State Geological Survey of Illinois published [18] a full report of its field and laboratory investigations of the method of rock-wool production, available sources of wool rock within the State, and potential markets. Early in 1935 announcement was made of the formation of the Mineral Insulation Co. for the erection of a two-cupola plant at Chicago Ridge, Ill. (near Chicago), the first in the State. Construction of a rock-wool plant, the first in Canada, was begun in 1934 by a subsidiary company of Queenstown Quarries, Ltd., at St. Davids (near Thorold), Ontario.

An interesting development in California is the attempt to utilize a deposit of wollastonite at Code Siding, Kern County, for making mineral wool, using the electric-arc process for melting. Ordinary rock wool is melted in water-jacketed cupolas, using coke as fuel, and the molten rock is fiberized by a jet of steam (or compressed air) as it issues from a small tap hole. In France, however, slag wool (laine de laitier) is made from granulated slag melted by oil burners in a refractory-lined vessel with a perforated bottom; the threads of slag issuing from the floor of the furnace are caught on a rotating cylinder where they are cooled by a spray of water so that they do not stick together as they are wound on the drum.[19] "Glass silk" was made in Germany as a war necessity and since 1930 has been manufactured also in England. It is made from a commercial glass batch heated in an electric furnace with apertures in the bottom. According to a recent description, the final product is a blanket of lightly felted fibers; the details of the manufacturing operations are reported as follows:[20]

> Ordinary commercial glass * * * is heated in electric furnaces which are provided with apertures through which the glass exudes when it reaches the molten state. As it exudes a skilled operator touches the spot with a glass rod, a strand

18 Lamar, B. S., and others, Rock Wool from Illinois Mineral Resources: Illinois State Geol. Survey Bull. 61, 1934. 262 pp.
19 Rock Products, Mineral-Wool Production in France: Vol. 33, no. 9, Apr. 26, 1930, p. 80.
20 Carlisle, Alex., "Glass Silk" as a Heat Insulating Material: Chem. Age, vol. 32, no. 811, Jan. 12, 1935, p. 28.

of the glass is drawn out, and this is deftly whisked across to a revolving drum alongside the furnace. The drum continues to revolve rapidly, drawing out strands from all the apertures and lapping them over and over until the drum is covered with a thick felt of the thin glass fibres. A cut is then made across the drum, and the spun glass comes away in the form of a blanket of fibres, each in the neighbourhood of 0.001 inch diameter. The fibres, as they come from the drum, lie almost parallel and possess such tensile strength that they can be folded and crumpled with no ill effect. Such blankets of fibres are "opened out" into fine layers which have the appearance of silky veils, and they are laid one upon another until sufficient thickness has been built up to give a good degree of heat insulation. Intimately meshed, the fibres enclose innumerable minute air spaces but no large pockets, and it can be readily appreciated that a felt which is an inch or two in thickness should be an excellent nonconductor of heat.

MONAZITE

Monazite has been produced commercially in the Carolinas, Idaho, and Florida, but no output has been reported in the United States since 1925. For a few years prior to 1895 (when monazite production was undertaken in Brazil) the United States was the sole source of world supply. Exports of monazite from Brazil amounted to several thousand tons annually for a number of years and declined only after the high-thoria sand from Travancore, India, entered world markets in 1911. Ceylon has also been a minor source of monazite. World production of monazite increased fairly steadily from 65 short tons in 1893 to a peak of 7,392 tons in 1909 and subsequently declined to 33 short tons in 1930. The output is erratic and may vary widely from year to year; in 1922, for example, it dropped to 379 tons compared with 1,861 tons in 1921, and later after minor ups and downs, it jumped from 100 tons in 1932 to 1,063 tons in 1933.

Monazite formerly was valued chiefly for its thoria content, which in domestic ores is too low to compete with Indian or even Brazilian material. However, with the decline in gas-mantle manufacture, which provided the principal outlet for thoria, and the development of additional uses for ceria and other rare earths, the trend apparently is toward valuing monazite for its rare-earth content. On this basis, Carolina monazite would not be classed as inferior to imported material and might eventually command a premium because of its high rare-earth content. It remains to be seen, however, whether such premium would sufficiently offset the much lower cost of production in British India, where labor is so cheap and where the monazite has become essentially a byproduct of the greatly expanded production of ilmenite for making titanium pigments.

As no monazite is mined in the United States, imports (assuming they are accurately reported) form a good measuring stick of consumption. The irregularity of shipments is indicated by the following table covering 1930 to 1934, inclusive:

Monazite sand imported for consumption in the United States, 1930–34

Year	Short tons	Value	Year	Short tons	Value
1930	(1)	(1)	1933	56	$1,935
1931	1,698	$65,080	1934	112	4,867
1932	1,569	48,639			

[1] None imported.

Since 1930 quotations for monazite have been about \$60 per short ton. Before July 1932 this figure was based on a minimum thoria content of 6 percent, but subsequently an 8-percent thoria content was specified, and a quotation of \$63 per short ton became effective. In June 1933 the price dropped to \$50 per ton—the lowest quotation so far recorded in the history of the industry—and remained there until May 1934, when it returned to \$60 per ton, a price that was in effect for the remainder of the year.

Monazite is now used as a source of ceria, formerly thrown away. Its thoria content likewise has found uses outside the manufacture of gas mantles. The oxide of thorium melts at 3,000° C. and may be used to resist temperatures up to 2,500° C. As it also resists chemical action it finds a small use as a refractory material, although its applications are limited not only because it is high in price but also because it is sensitive to sudden changes in temperature.

OLIVINE

Two or more companies were producing olivine in North Carolina in 1934, and shipments of this material were made for refractory purposes as early as 1930. The Bureau of Mines became interested in olivine and sent samples to the National Bureau of Standards in April 1932; in December 1933 that Bureau in its Technical News Bulletin 200, page 127, summarized results of tests of 3 types of material from North Carolina and 1 each from California, British Columbia, and the U. S. S. R. (Russia). The P. C. E. (softening point) of these samples ranged from 30 (1,650° C.) to about 35 (1,785 + ° C.), except for high-lime material which softened at cones 11 to 16. The North Carolina olivines were more refractory than those from other sources, and the article ended with a statement that the North Carolina material "was sufficiently refractory to temperature and to certain slags to warrant classifying it as a so-called 'special refractory.' Bricks made from run-of-mine material gave satisfactory results * * * ." A more extended report was issued later.[21]

Pure magnesium orthosilicate melts at 1,925° C. and theoretically contains 43 percent SiO_2 and 57 percent MgO. Ordinary olivine has a large iron content, but in North Carolina huge deposits of a high-magnesia product occur, and commercial shipments have analyzed as follows:

	Percent		Percent
SiO_2	40. 35	CaO	0. 60
Al_2O_3	. 63	K_2O, etc	. 27
Fe_2O_3	7. 64	Ignition loss	. 88
Cr_2O_3	. 32		
MgO	49. 45		[22] 100. 14

The material is offered f. o. b. cars, in several forms, including natural cut blocks which are hand-hewn to various sizes weighing 50–200 pounds. A recent price schedule is as follows, per short ton:

F. o. b. Balsam or Green Mountain, N. C.:	
Spalls	\$6. 00
Crude	8. 00
Cut blocks	30. 00
F. o. b. Spruce Pine, N. C.:	
Crushed	\$15. 00
Ground	20. 00

[21] Heindl, R. A., and Pendergast, W. L., Olivine as a Refractory: Nat. Bur. of Standards, Research Paper 645 (part of Nat. Bur. of Standards Jour. Research, vol. 12, February 1934, pp. 215–222).
[22] If the iron was reported partly as FeO, the total would be under 100 percent.

Considerable interest has been aroused by adding magnesia (calcined magnesite) to olivine, serpentine, talc, or other natural silicates. British Patent 283791, issued to V. M. Goldschmidt and R. Knudsen, covered the use of natural olivine rock for furnaces and other equipment exposed to high temperatures or to chemical action, and British Patent 337605, issued to Metallgesellschaft A.-G., November 7, 1929 (also French Patent 721545, Aug. 3, 1931 and German Patent 582893, Aug. 24, 1933), covers the process of heating (to around 1,500° C.) olivine and allied minerals with substances rich in magnesium in an oxidizing atmosphere to convert the iron into magnesium ferrite and the free silica into magnesium orthosilicate.

The Ural dunite tailings obtained in the extraction of platinum in the U. S. S. R. (Russia) contain 35 to 40 percent olivine, 50 to 55 percent serpentine, and 10 percent magnetite or chromite; the high iron content causes it to burn dark at 1,200° to 1,300° C., and it loses water at 600° to 800° C., with as much as 10 percent loss in weight. It can be used as an admixture with clay and chrome ore for furnace brick and cement but is not suited for refractory ores when used alone.[23]

The use of olivine refractories is still in the experimental stage, but olivine offers possibilities for lining furnace floors and walls, as it is much cheaper delivered at eastern metallurgical plants than magnesite or chrome. It does not have to be burned (calcined) before use.

STRONTIUM MINERALS

World requirements of strontium minerals generally have been less than 10,000 tons annually, and Germany has consumed most of them owing to its use of the Scheibler process for beet-sugar making. One firm at Rosslau, Germany, affiliated with the Dessauer sugar refinery, dominates the German situation, and in the United States the Grasselli Chemical Co. is by far the principal consumer.

Celestite deposits have been found in various States but have not been worked except during the World War when the normal flow from oversea sources was interrupted. Domestic requirements, formerly supplied by imports of strontium salts from Germany, have been filled recently by imports of celestite from England, the principal producing country. During the last 3 or 4 years it has become increasingly apparent that potential supplies of strontium ores in the United States are much greater than was previously known. In the general vicinity of Boulder Dam there are numerous deposits, one of which (near Argos, Calif.) contains over 600,000 tons. According to Moore,[24] these deposits contain much material that is more than 90 percent strontium sulphate, and enormous tonnages of 70- to 90-percent material, contaminated chiefly with inert silica, could be mined very cheaply. Other potential sources of cheap celestite have been opened in Texas and other Western States as well as in Mexico. Virtually unlimited supplies of celestite accordingly could be made available quickly at a cost of less than $10 a ton delivered at Atlantic seaboard points and at even lower prices in certain western centers.

Known deposits of strontianite in North America are too meager to encourage development. The natural carbonate is more convenient

[23] Ominin, L. V., Dunite as a Ceramic Material: Mineral. Suir'e, vol. 9, no. 2, 1934, pp. 29-33; Chem. Abs., vol. 28, no. 16, Aug. 20, 1934, p. 5196.

[24] Moore, Bernard N., Some Strontium Deposits of Southeastern California and Western Arizona: Am. Inst. Min. and Met. Eng. Tech. Pub. 597, 1935, 24 pp.

than the sulphate for the manufacture of many chemicals, but celestite can also be used; in fact, the sulphate may be converted directly to the carbonate by treatment with soda ash (e. g., United States Patent 1936806, assigned to Grasselli Chemical Co.), although standard methods follow those employed in the barium chemical industry, involving the initial production of a soluble sulphide ("black ash"). Strontium also occurs as a minor constituent of various brines, and a series of patents obtained by the Dow Chemical Co. relate to the recovery of such strontium from mother liquors from which magnesium has been removed as tachydrite.

If domestic resources of strontium minerals are to be utilized extensively, new uses will have to be developed. Beet-sugar refiners in the Western States, except for one company which employs a barium process, use the lime process, which is much cheaper although not quite as efficient as the strontium process. In most American localities lime is so cheap that it is not worth while to recover it. In the Scheibler process, on the other hand, it is customary to recover the strontium as a precipitated carbonate which then has to be converted into a hydrate for reuse; the unavoidable loss, about 5 percent, is an additional charge against the process. In this country the leading application of strontium is the use of the nitrate in fireworks. Strontium signal flares have long been standard equipment on virtually every American railway, but obviously this is not a very large outlet or one that can be expanded greatly. Attempts to find uses for the metal so far have failed to foreshadow any tonnage demand. The pharmaceutical and laboratory uses naturally are destined to be limited, and the same may be said of the use of strontium compounds in cathode discharge tubes and similar electron-emissive devices. A new use [25] for strontium chloride powder has been developed in a gas refrigerator which operates on the solid absorption principle; each refrigerator requires about 7 pounds of the strontium chloride with lithium nitrate as a binder. Celestite probably can be pulverized to extremely fine particle size more readily than barite, in which case it may replace ground barite, or perhaps even blanc fixe, for sundry filler uses, provided it can be offered at a competitive price. Besides being bulkier for a given weight it is said to be preferable to barium sulphate as a rubber filler. The only other possibility of a new tonnage outlet seems to be its use in the steel industry, but this calls for a carbonate rather than raw celestite. Strontianite added to a basic open-hearth steel furnace acts as a flux and increases fluidity of the slag without reducing its basic character (evidently acting somewhat like fluorspar in this respect), but the main advantage claimed is removal of excessive sulphur (down to 0.2 percent) such as occurs in certain European pig iron and scrap steel.

The production of celestite in Gloucestershire, England, declined from 4,052 long tons in 1931 and 6,852 tons in 1932 to 3,862 tons in 1933. In 1913 the output was over 20,000 tons, and as early as 1884 it amounted to over 12,000 tons, the highest record being 36,000 tons in 1902. Strontianite is a rather uncommon mineral. It is not mined outside of Germany, and the output is small and irregular. Strontium minerals occur in a number of other countries, but England and Germany have been the principal producers, and the declining output in these countries has not been offset by exploitation of deposits elsewhere.

[25] Metal and Mineral Markets, New Use of Strontium Chloride: Vol. 3, no. 11, Mar. 17, 1934, p. 5.

The small quantity consumed in the United States is indicated by imports. Prior to 1914 no strontium salts were produced on a commercial scale in the United States, and domestic needs accordingly were measured by imports of salts (almost wholly from Germany), amounting in the fiscal year 1914 to 1,941,103 pounds valued at $103,362, of which 1,834,733 pounds valued at $95,490 were technical nitrate and 26,921 pounds valued at $3,017 nitrate powder. As domestic manufacturers carry rather heavy stocks, imports of ore fluctuate considerably from year to year. From 1926 to 1929 the value of imports of strontium minerals was extraordinarily high; an analysis of these figures as reported, however, shows that a large part of these abnormal receipts was credited to Germany and valued at over $40 a ton compared with a current valuation of only $6 or $7 per ton for the normal importations of celestite from England. Possibly this German material instead of being strontianite was a precipitated carbonate such as is recovered at sugar refineries. In later years imports of ore have come wholly from Great Britain and have been well maintained, whereas those of strontium nitrate and other compounds, almost exclusively from Germany, have dwindled.

Strontium minerals and chemicals imported for consumption in the United States, 1925–34

Year	Minerals		Nitrate		Carbonate		Oxide	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1925–29 (average)	2,567,658	$43,123	1,868,113	$105,412	52,346	$3,249	2,335	$245
1930	440,924	10,459	1,678,886	92,166	33,978	2,182	----------	----------
1931	260	123	1,701,750	80,889	29,452	2,022	11,252	520
1932	11,685	276	438,931	18,699	30,550	2,211	----------	----------
1933	2,426,493	8,457	532,835	23,744	10,073	850	595	115
1934	2,500,411	9,218	237,105	13,796	28,416	3,284	2,204	469

Celestite has been quoted recently in Metal and Mineral Markets at $35 per short ton for a 90-percent product, finely powdered, but the average value of the English crude material as reported in the import statistics for 1933 and 1934 was about $7 a short ton f. o. b. Bristol, England, equivalent to about $10 a ton delivered at United States Atlantic seaboard. In 1915 the price of celestite, f. o. b. Bristol Dock, was 14s. 2d., or $3.45 per long ton. Before the World War strontium nitrate was generally worth about 7.25 cents per pound in the United States compared with an average import valuation in 1914 of 5.2 cents per pound. Prices soared during the war period but subsequently receded to 8 cents in 1926. In 1934 the import valuation was down to 5.8 cents, and the quotation f. o. b. domestic works, in barrels, was 8.75 cents. The technical carbonate has been quoted recently at 7.25 cents and the peroxide at $1.25 a pound. The price of strontium metal, formerly over $30 per pound, has been reduced progressively until now it may be obtained in large quantities on contract basis at less than $10 a pound.

VERMICULITE

The term "vermiculite" is applied to a group of foliated minerals, generally alteration products of biotite, phlogopite, or other varieties of mica, that expand extraordinarily on heating. The increase in volume may be as much as sixteenfold, but it takes place in only one direction as it is a process of exfoliation at right angles to the cleavage. Water of constitution is given off, and the color changes from greenish brown or dirty bronze to a silvery or golden hue, depending upon the degree of heat and exposure to the air.

For almost a century after it was named and described by Webb in 1824 vermiculite was merely a mineral curiosity. The Japanese, it is said, used to amuse themselves by throwing pieces on hot coals to see it exfoliate. The commercial implications of the peculiar behavior of the material when heated were not developed vigorously until the organization of the Zonolite Co. by E. N. Alley, who discovered a large deposit of vermiculite at Libby, Mont., in 1916 and began commercial production on a small scale in 1921. The variety of vermiculite known as "jefferisite" was found first at the Brinton quarry, West Chester, Pa., many years ago, but the output from this operation has been irregular and quite small. Vermiculite has also been produced in Wyoming, Colorado, North Carolina, and one or more other States. Occurrences of possible value but hitherto unworked have been reported to the Bureau of Mines as in Arizona, California, and Georgia, and specimens of altered black mica exhibiting a small amount of expansion have been forwarded from other States. According to a report of the State geologist,[26] considerable commercial material could probably be recovered from deposits thus far discovered in Georgia by suitable washing, but the future of the vermiculite industry of that State probably depends on the discovery of deposits pure enough to be marketed without expensive treatment before expansion.

Production figures are not available, but as early as 1929 the Zonolite Co. was said to be producing and marketing over 1,000,000 pounds of material annually under its trade mark. Although occasional contributions have been made from other sources, the history of the industry until about 1932 was essentially a record of the educational sales effort of this one company. F. E. Schundler then became interested in vermiculite and soon developed a screening process whereby the weight of the material was reduced to 6 pounds or less per cubic foot. He also built a new expanding plant at Joliet, Ill., to take advantage of lower freight rates obtainable on raw vermiculite than on the semifinished product.

During 1934 control of the Zonolite Co. was sold to W. B. Mayo and associates, of Detroit. The new owners announced a development program to include construction of a plant to refine "Zonolite" at the mine and a tram to move the refined product from the plant to the Great Northern tracks. The Zonolite Co. now ships more than 3,000 tons of vermiculite a year. F. E. Schundler & Co., Inc., which now operates plants for treating vermiculite at Brooklyn, N. Y., as well as at Joliet, Ill., and acts as distributor for products of the Zonolite Co., is reported to have quadrupled its facilities for treatment of vermiculite and other nonmetallic minerals by construction of a new plant in Long Island City, and is contemplating the use of over 20,000 tons annually.

The National Vermiculite Products Corporation, Chicago, Ill., acquired the property and assets of the Vermiculite & Asbestos Co.,

[26] Prindle, L. M., Kyanite and Vermiculite Deposits of Georgia: Geol. Surv. of Georgia Bull. 46, 1935, p. 46.

Libby, Mont., during 1934 and undertook to enlarge the plant at the mine. The Bear Paw Mining Co. has done some development work on a deposit south of Havre, Mont., and two or three other vermiculite deposits in the State have been brought to the attention of the Bureau of Mines. In Colorado several companies and individuals have been active in the production of vermiculite. According to news reports vermiculite was shipped from Fremont County, Colo., by the Vermiculite Products Co. and from Westcliffe by Zip Belisle. Mrs. Winona Sparling of Rosita, Colo., is also reported to have shipped a number of cars of vermiculite in recent years. Allied Minerals, Inc., of Canon City, Colo., controls deposits at Dead Mule Gulch, Hillside, and Feldspar, Colo., and has undertaken development work and market research. Vermiculite has been produced in Wyoming, and some attention has been given to deposits in Arizona, but at present commercial developments in the West appear to be concentrated in Colorado and Montana. In the East, interest in vermiculite apparently is centered in North Carolina. Many of the specimens submitted to the Bureau of Mines from that State have been somewhat inferior to high-grade Montana material as regards degree of expansion on heating, but suitable commercial deposits have been found at a number of localities in North Carolina, and one producing company has announced its intention to build a plant for preparing vermiculite for market.

Vermiculite is used principally for heat, cold, or sound insulation, and for such purposes it first has to be expanded. A detailed discussion of the preparation and uses of the mineral, as developed by the Zonolite Co., is included in a paper by Steele [27] presented at the February 1934 meeting of the American Institute of Mining and Metallurgical Engineers. Applications for the product range from the insulation of dry-ice containers chilled to 60° below zero to protection for the tops of open-hearth furnaces with standing temperatures higher than 2800° F. Vermiculite may be employed loose as a filler in the walls of houses; in bake ovens, water heaters, thermal jugs, safes, stoves, furnaces, or refrigerators as a thermal insulator; or in wall panels in motion-picture sound studios, where it is important to confine noises to a given area. It also serves as a lightweight aggregate in insulating plasters, cements, nailing concrete, and other plastic hydraulic materials where insulating and sound-deadening properties and low specific gravity are of value, or it may be prepared as an acoustical tile. The attractive golden color of heat-treated vermiculite adapts it to use for decorative purposes, such as in wall paper and gold paint.

Quotations for vermiculite have appeared in trade journals only since the early part of 1933 and have been more or less nominal at $7 per ton, f. o. b. mines, North Carolina. In June 1934 the price rose to $7.50 and remained at that figure for the rest of the year. In 1933 raw "Zonolite", predried and screened, sold for $15 per ton, f. o. b. Libby, Mont., in bulk, and expanded material was sold from the Schundler expanding plant at Joliet, Ill., at $45 per ton. The freight rate from Libby to Joliet was $8 a ton on crude material.

[27] Steele, William S., Vermiculite—Production and Marketing by the Zonolite Co.: Trans. Am. Inst. Min. and Met. Eng., vol. 109, 1934, pp. 418–426.

PART IV. MINE SAFETY

SAFETY IN MINING

By D. Harrington

SUMMARY OUTLINE

Mining is generally recognized as a dangerous occupation. It usually ranks as one of the most hazardous in which large numbers of men are employed.

Most mining operations are carried on underground, in confined places, where adequate lighting is difficult to obtain. Frequently the rock stratum under which the miner works requires much care to prevent its falling. Explosives in large quantities and machinery must be used, both under conditions more hazardous than on the surface. Irrespirable or explosive gases are given off in some mines. These facts and other conditions make the prevention of accidents in mining more difficult than in surface industrial work, even of the more hazardous types. Moreover, while errors in connection with accident prevention in surface work are likely to affect only one or possibly a few persons, such errors in underground mining may readily cause an explosion or other untoward occurrence that will result in the death of scores or even hundreds of persons.

The difficulties of preventing accidents in and around mines are well known. Most foreign countries and most States in the United States have regulations providing for the safety, and, to a smaller extent, the health of the workers. However, as far as the United States is concerned, such regulations usually are a mere skeletonized outline of some fundamental minimum requirements; none of them is adequate, and most of them are grotesquely out of date as applied to present-day conditions. There is urgent need for modernizing and effecting a closer correlation of the laws and regulations of the various mining States with regard to the safety and health of the workers. Although mining conditions differ in the various States, there are numerous standard and fundamental safety provisions that apply to all kinds of mines; these should be embodied in the mining codes of all States. Such standard safety requirements doubtless would be opposed by some mining companies, but the requirements would ultimately prove beneficial to the mine owners, the workers, and the general public.

Progressive mining companies for many years have gone beyond the meager requirements of the safety laws and regulations of the States and have adopted additional and more effective procedure of their own, although complying also with the State laws. As a result of this forward-looking policy many of these companies have made astonishing progress in the reduction of accidents. Numerous such companies could be cited in all branches of the mineral industry, including anthracite and bituminous-coal mines; metal mines; nonmetallic mineral mines; coking plants; milling, smelting, and metallurgical establishments; and the various activities in connection with the production and processing of petroleum. The success of such companies in the prevention of accidents frequently has extended over many years.

DOWNWARD TREND IN ACCIDENT OCCURRENCE

Considerable progress has been made in the mines of the United States in the prevention of accidents, especially explosions in coal mines. Most of us remember having frequently read headlines in the daily press calling attention to some terrible mine disaster. Fortunately such disasters seldom occur now, and, when they do, the number of lives lost is much smaller than it was in earlier years.

During the 5-year period, 1906–10, there were 84 major disasters (those in which 5 or more lives were lost) in the coal mines of the United States. Most of these disasters were explosions of gas and dust. The loss of life from explosions, both major and minor, during that period totaled 2,388 and averaged 478 per year. The shocking loss of life in these disasters and the frequency of the explosions roused the country and caused the public to demand some action by the Federal Government. This was largely instrumental in the establishment of the United States Bureau of Mines in 1910. The new Bureau pioneered in research into the causes and methods of preventing mine accidents and gave special attention to preventing explosions in coal mines. Through this research work and other activities of the Bureau, together with the activities of State mining departments, mine operators, and others, the occurrence of explosions has been greatly reduced. In 1933 there was only 1 major disaster in the coal mines of the United States; in 1934, only 2. During the 24 years of existence of the Bureau of Mines, the apparent saving has been 7,300 lives from gas and dust explosions alone, an average of more than 300 per year—lives that would have been lost if explosions had been permitted to continue with the frequency and magnitude that characterized those before the Bureau was established. Rock-dusting, one of the numerous measures recommended by the Bureau of Mines to check or prevent mine explosions, has unquestionably been instrumental in saving at least 200 lives annually during the past 6 or 7 years and in preventing property damage of several million dollars a year.

The number of persons killed by all classes of accidents, including explosions, in and about the coal mines of the United States during the 5-year period 1906–10, averaged 2,658 per year, and the fatality rate for the same period averaged 5.89 per year per million tons of coal produced. This rate was reduced to 3.31 in 1931, 3.36 in 1932, and 2.78 in 1933. Preliminary figures for 1934 indicate a rate of 2.77, but when final reports are received this rate probably will be increased to about 2.85, or next to the lowest death rate per million tons of coal produced in the history of coal mining in the United States, the lowest or best rate on record being 2.78 for 1933. Had the rate of 5.89 for 1906–10 continued to the 1st of January 1935, the lives lost in coal mines would have been 25,500 more than the number recorded; thus an average annual saving of nearly 1,100 lives is indicated for the 24 years since 1910. Similar figures for nonfatal accidents in coal mines are not available, but as there are about 50 nonfatal injuries to 1 fatality it is probable that at least 50,000 nonfatal injuries have been avoided or prevented during each of the past 24 years in our coal mines alone, or a total of more than 1,200,000 during the 24-year period.

Especially encouraging has been the progress in safety in the mining and allied industries from 1930 to 1934, notwithstanding the numerous vicissitudes which have been thrust not only upon health and safety workers and employees in the mineral industries but upon the public at large. For the first time since health and safety in the mines of the United States have been actively fostered, those engaged in this work have been able not only to see trends toward better things but actually to find those trends substantiated by undeniable facts and figures showing the utter fallacy of the belief held by many persons that mining is so inherently unsafe that efforts to operate mines safely are necessarily futile.

Table 1, taken from data in Bureau of Mines publications, gives some illuminating information on the occurrence of fatal and nonfatal accidents in our mines and quarries. The figures for metal mines and quarries cover both fatal and nonfatal injuries; those for coal mines cover fatalities only, as figures covering nonfatal injuries in coal mines are not available for years prior to 1930.

TABLE 1.—*Accident rates in metal mines, quarries, and coal mines in the United States, 1911–34*

Period	Metal mines	Quarries	Coal mines	
	Men killed and injured per thousand 300-day workers	Men killed and injured per thousand 300-day workers	Men killed per thousand 300-day workers	Men killed per million short tons of coal produced
Average for—				
1911–15	202.38	91.58	4.65	4.76
1916–20	245.04	162.39	4.03	3.86
1921–25	276.27	175.22	4.58	3.96
1926–30	213.22	140.77	4.61	3.75
Average for—				
1926	248.48	162.15	4.50	3.83
1927	224.64	164.55	4.43	3.73
1928	208.11	131.41	4.64	3.78
1929	203.14	129.79	4.54	3.59
1930	170.78	109.76	5.00	3.84
1931	142.09	106.04	4.42	3.31
1932	138.46	97.33	4.60	3.36
1933	155.13	97.59	3.58	2.78
1934	(1)	(1)	(1)	[2] 2.77

[1] Not available. [2] Subject to revision.

As shown in the foregoing table the first real break to reasonably low levels in the accident rate for metal mines was in 1930. Before then the rates had improved but little, as is indicated by those for the four 5-year periods between 1911 and 1930. The improvement begun in 1930 continued through the next 2 years, and although there was a slight set-back in 1933 the accident rate was still well below that in 1930. The rate for 1934 is not yet available.

The accident rate for the quarrying industry showed a definite drop as far back as 1928. Each year since then, except 1933, when the rate rose slightly above that for 1932, the accident rate has declined, indicating that the quarrying industry now has accident-prevention work well in hand.

In coal mines, as previously indicated, a long-time record is available for fatalities only, as records for nonfatal accidents are not available for years prior to 1930. The fatality rates per million tons of coal produced remained obstinately high after it had been lowered from 4.76 for the 5-year period 1911–15 to 3.86 for the succeeding 5-year period 1916–20. The rate approximated 3.85 until 1931, when it was reduced to 3.31, the lowest rate known until that year. The next year, 1932, failed to equal the favorable record of 1931, but the rate of 3.36 established in 1932 was next to the low-record rate of 1931. The rate for 1933 was 2.78, by far the lowest, or best, rate in the history of coal mining in the United States. Preliminary figures for 1934 give a rate of 2.77, but when final figures are assembled this rate is likely to be raised to about 2.85, which is much lower than that of any other year in the history of coal mining except 1933. Because of the prime importance of coal in American life and industry the fatality rates for coal mining are presented both on a per-million-ton basis and a per-thousand-300-day-employee basis. The downward trend of the rates on the per-million-ton basis appears more favorable because the rates are influenced frequently in a manner detrimental to safety by an increasing productivity of mine labor through technological improvements in equipment and methods of conducting mining operations.

Obviously safety should be considered, whether in mining or in any other walk of life, primarily from the humanitarian standpoint, as the prevention of loss of life and limb with the attendant sufferings and social repercussions is a goal well worth almost any expendable effort. Unfortunately, however, human nature is so constituted that constant and universal application of high-minded principles day in and day out to the prosaic features of industrial work are not, and probably never will be, obtainable. It is now evident to those most experienced in accident-prevention work that a higher degree of safety is likely to be achieved only when the officials in charge of mining or any other type of industrial projects actively support and encourage safety programs, and generally, although not invariably, the attitude of mining-company executives can be interpreted in only one manner—safety expenditures must show a dollar-and-cents return on the investment. Hence, if safety is to be given any appreciable attention it must show a profit. A superintendent of a coal mine in which accidents from falls of roof and coal were occurring with undue regularity was informed by a trained safety engineer that the accidents could certainly be greatly reduced if more timbers were used; the reply was that additional timber would cost extra, therefore this accident-prevention plan was given scant consideration even though not only accident occurrence but also accident cost probably would have been reduced if the plan or a good modification of it had been adopted. A similar viewpoint is held by many superintendents, general superintendents, general managers, vice presidents, and presidents of mining companies, especially when these officials reside in some large city a considerable distance from the mine. Safety directors and safety workers in immediate contact with the mine usually consider saving in human life and suffering justification enough for spending money on safety even if the company would receive no immediate dollar-and-cents return for such expenditures. To the surprise of most safety workers a rigid accounting frequently reveals that so-called "philanthropic" expenditures for health and safety in mining have also paid large dividends in the form of cost reduction.

COST OF ACCIDENTS

When an accident occurs, the losses sustained fall upon both the employer and the injured employee or his family. The employer's losses are largely monetary, and most of them can be measured in dollars and cents; those of the injured employee or his family consist chiefly of mental and physical suffering and are not measurable except as to the compensation paid to the employee or his family, and the amount so paid is usually much less than the employee would have earned if he had continued to work uninjured.

Direct and indirect costs.—The losses of the employer are both direct and indirect. The direct losses are readily ascertained; they comprise the compensation paid to the injured man or his family, medical and surgical fees, hospital fees, and funeral expenses of employees killed by accidents. The indirect, although none the less real, losses of accidents to employers are more difficult to ascertain and are often overlooked. They are due to events and conditions which are normally to be expected to follow the occurrence of an accident. When an employee is injured considerable time is lost by other workmen, either in assisting the injured man, in viewing the place where the accident occurred, in discussing the incident with fellow workmen, and in clearing away wreckage due to the accident. These items are expensive to the employer, who is also put to the additional expense of employing and training new men to replace employees killed or those injured and unable to return to work. In some mines all men stop work if an employee is killed; thus production slows up or stops whenever an accident occurs, and lost production may seriously affect profits. Moreover, many accidents occur in and around mines without injury to persons but with much damage to property and with heavy loss to the company. Again, one of the serious factors in the indirect or hidden cost of accidents is the expense to the employer for noncompensable accidents.

Probably the direct cost of accidents in and around the coal mines of the United States averaged at least 4 or 5 cents a ton of coal mined with wages and contract rates as of 1931 and 1932 and about 5½ to 6 cents a ton in 1933 and 1934. Similar figures cannot be given for metal mines, nonmetallic mines, and tunnels; but the cost per $100 of pay roll is estimated to be from a low of $3.40 to $4 to as high as $15 for metal mines and perhaps as high as $35 for tunneling.

The indirect cost of accidents in dollars and cents, which the employer sustains when accidents occur, has been estimated to be at least four times the direct cost; hence the cost of compensation and hospitalization is thought to be only about one fifth of the total cost to the employer. On this basis, coal-mine accidents in one State (Washington) represented an indirect cost of 32.20 cents per ton of coal produced from 1913 to 1929. On the same basis, accidents in the bituminous mines of Pennsylvania from 1926 to 1930 represented an indirect cost of 11.72 cents per ton; during the same period in anthracite mines in the same State the cost was 21.72 cents per ton.

Probably the most convincing exposition of the far-reaching consequences of the indirect cost of accidents is to be found in a paper entitled "The Cost of Industrial Accidents to the State, the Employer, and the Man", by H. W. Heinrich, of the Travelers Insurance Co., as read by him before the International Association of Industrial Accident Boards and Commissions, in Wilmington, Del., on September 23, 1930.

When all of the factors are considered that enter into the indirect cost of accidents (including those in which injury or death occurs and those which do not result in personal injury), one is forced to believe that the indirect cost must be several times (and probably at least four times, as is usually given) the direct cost of accidents. It therefore behooves the mine management to try to its utmost to avoid the occurrence of all kinds of accidents in and around the mines. While this may seem at first to be Utopian and impossible of fulfillment, the results now being obtained by many mining companies with well-directed safety effort give ample promise that the goal may be reached approximately if not absolutely.

Accidents a factor in production costs.—It appears that the direct cost of accidents in coal mining is at least 4 cents per ton of coal produced (and probably nearer 5 cents per ton) and that the direct cost in metal and other types of mining is around or over $5 per $100 of pay roll. If the indirect cost is four times the direct cost, as is now thought to be approximately correct, then the total cost (direct plus indirect) of accidents in coal mining in the United States is about 20 cents, or possibly as much as 25 cents, per ton; and the total cost of accidents in metal and nonmetallic mining is around $25 per $100 of pay roll.

Probably 20 cents per ton is not too high as an estimate of the total cost of accidents in coal mining, and certainly 15 cents per ton is far too low a figure. Twenty-five dollars per $100 of pay roll seems high for the total cost of accidents in metal and nonmetallic-mineral mining, but $18 or $20 is conservatively low. These figures are 10 or more percent of the mine cost of production, and probably no less than 10 percent of the mine cost of producing coal, ore, or nonmetallic-mineral products in this country is due to the occurrence of accidents.

COMPARISON OF ITEMS IN COMPENSATION COST OF ACCIDENTS

Compensation payments.—The figures on the cost of accidents, as published by the compensation commissions of the various States, do not conform to any specific standard, and it is practically impossible to correlate much of the data. For some States the figures cover hospital and medical expense; for others only the compensation outlay is given. Even the compensation for any given type of injury varies from State to State. Typical sums covering compensation alone are given for seven States in table 2. While the figures in the table are not comparable because of variations in State laws, the sums provided for fatal accidents range from $3,193 for general industrial accidents in West Virginia to $6,900 for quarry accidents in New York. For permanent total disabilities the average compensation costs ranged from $6,526 for bituminous-coal mines in Pennsylvania to $15,484 for mining (principally copper mining) in Arizona. It may be stated here that Arizona has one of the most drastic compensation laws in the United States, and that, while this fact is reflected in high individual costs, the progressive mining companies in that State have been able to overcome the supposed handicap by intensive safety work and have held their compensation costs per $100 of pay roll to a low level. The costs of permanent partial disabilities, as shown in table 2, range from $506 for mining in Washington (1930) to $3,686 in Arizona (1926–29). The cost of temporary disabilities in mining ranges from $15 in New York to $108 for bituminous mines in Pennsylvania. One total disability in California finally resulted in a fatality 15 years later, bringing the hospitalization costs alone (including services of doctors, nurses, etc.) to more than $43,000.

Medical and hospital costs.—Compensation payments are only part of the direct cost of accidents. Medical, hospital, and burial costs average one-fourth to one-half as much as the compensation cost. The ratio is, of course, influenced greatly by the number of fatalities and permanent total disabilities in relation to the number of nonfatal injuries of a slight degree of severity. In California, during the 5-year period 1924–28, compensation was $1,054,580 and medical aid $505,142, the latter being 48 percent of the compensation cost and 32 percent of the total direct cost. During the 4 years ended December 31, 1930, a group of mines in Arizona had a medical-aid cost amounting to 18½ percent of the compensation cost and nearly 16 percent of the total cost. In Tennessee the medical cost for 13 mines was 32 percent of the compensation cost and more than 24 percent of the total cost. In Pennsylvania, from 1925 to 1929, inclusive, medical cost was 65½ percent of the compensation for temporary disabling injuries in bituminous mines and about 7½ percent of the compensation for deaths. One coal-mining company which, through a material reduction in accident occurrence, had lowered its direct cost of accidents from 7½ cents to 1½ cents a ton, had at the latter figure a hospitalization cost (doctor plus hospital charge) of 33 percent of the compensation cost and 25 percent of the total direct cost of accidents. Ryan [1] states that the "medical attention and hospitalization" cost of producing coal is one-half cent a ton in addition to a compensation cost of 5 cents a ton. This would suggest that the cost of medical attention and hospitalization is 10 percent of the compensation cost of accidents in coal mines.

The cost of medical attention and hospitalization is greatly increased when wounds become infected. A large metal-mining company, in a bulletin issued to its employees, estimated that about 250,000 cases of infected wounds develop in industry every year; that insurance companies pay 40 to 60 percent of their compensation for

[1] Ryan, J. T., Profits Through Reduction of Accidents: Min. Cong. Jour., September 1932.

infected wounds; that infected wounds require an average of 18 weeks longer to heal than do noninfected wounds; and that most of the wounds that become infected start as minor scratches or cuts, usually to the hands and fingers, and could easily be prevented from becoming infected by first-aid or prompt treatment by a doctor.

TABLE 2.—*Average compensation cost of accidents in 7 States, by severity of injury* [1]

State	Type of industry	Period	Average cost for each injury				
			Temporary disability	Permanent partial disability	Permanent total disability	Death	Average compensable disability
Arizona	Mining	1926–29	$77	[2] $642; [3] 3,686	$15,484	$6,521	$372
Indiana	Coal mining	1930					304
	Do	1931					334
New York	Mining	1930	15	633		6,603	415
	Quarrying	1930	18	999		6,900	649
	General	1930					321
Pennsylvania	Bituminous	1927–31	108	2,429	6,526	3,786	312
	Anthracite	1927–31	107	2,084	6,829	4,572	387
Tennessee	13 coal mines	1926–31					250
Washington	Mining	1924–30	38	830	8,624	5,348	244
	Do	1930	47	506	9,334	6,664	376
West Virginia	General	1913–32		945	6,891	3,193	94

[1] Data taken from:
Ash, S. H., Accident Experience and Cost of Accidents at Washington Metal Mines and Quarries: Tech. Paper 514, Bureau of Mines, 1932, 35 pp.
New York Department of Labor, Cost of Compensated Cases: Special Bull. 178.
Ott, Lee, Nineteenth Annual Report of State Compensation Commissioner, West Virginia, for year ending June 30, 1932.
Herbert, C. A., A Review of Coal-Mine Fatalities in Indiana During the Fiscal Year Oct. 1, 1931, to Sept. 30, 1932: Inf. Circ. 6746, Bureau of Mines, 1933, 16 pp.
Pennsylvania Compensation Rating and Inspection Bureau, Annual Report of Coal Section. (Mimeographed report.)
Fene, W. J., Accident Experience and Cost in Pennsylvania Anthracite and Bituminous Mines, 1926–30: Inf. Circ. 6618, Bureau of Mines, 1932, 29 pp. Also unpublished data available to author.
[2] Disability of 18 months or less.
[3] Disability of more than 18 months.

Funeral costs.—In numerous fatalities in mining the victim has no dependents. In such cases the only direct cost, at least in some States, is that of a funeral. Funeral costs at coal mines in Pennsylvania averaged $103 from 1916 to 1930. In West Virginia the cost of a funeral has been fixed at $150.

Average cost of accidents.—Considering all compensable injuries, although, as previously stated, they are by no means comparable for different States, the average costs ranged from $94 per accident for coal mining in West Virginia to $649 per accident for quarrying in New York. The average cost of industrial injuries in New York in 1930 was $321, which agrees closely with an average estimate of $300 frequently made for compensable nonfatal industrial accidents in general.

It is believed that $100 is a fair and conservative average for the cost of nonfatal compensable and noncompensable accidents in mining in the United States, as many nonfatal injuries in mining entail an expense of as little as $10 and thousands of accidents involve dollars-and-cents costs far less than $10 each.

Maximum compensation payments allowable.—The maximum compensation payments allowable under the compensation laws of various States have been calculated and tabulated in table 3. Where the State law specifies death or remarriage of the beneficiary, a life-expectancy of 20 years has been used. As previously stated, only funeral expenses need be paid when a deceased workman leaves no dependents. Where the workman leaves dependents the maximum compensation allowable for death ranges from $3,000 in New Hampshire to $50,000 (under some conditions) in Arizona.

Funeral expenses paid when a deceased workman leaves no dependents may be as low as $75, as in New Mexico. However, at least eight States have special provisions governing payments where no dependents are left, and these provisions require the employer to contribute to a rehabilitation or special fund or to a second-injury fund. Payments in such cases may run as high as $6,600, as in Arizona.

Permanent total disabilities generally entail the greatest compensation cost, ranging from $3,000 in South Dakota to possibly more than $50,000 in Arizona. The maximum payments allowable for permanent partial disabilities range from $1,500 in Wyoming to $20,800 (estimated) in North Dakota. Temporary total disabilities, which comprise by far the majority of lost-time industrial accidents, range in cost from $832 in West Virginia to an estimated high of $20,800 in North Dakota.

Medical and surgical costs are unlimited in a number of States, but estimated maximums range from $100 to $800.

TABLE 3.—*Maximum compensation payments allowable, by States*[1]

State	Death		Burial	Total disability		Partial disability	Medical aid
	Dependents	No dependents		Permanent	Temporary		
Alabama	$5,000	$100	$100	$5,000	[2] $4,500	[2] $4,500	$100
Arizona	[3] 50,000	[4] 1,000	150	[5] 50,000	[6] 6,500	[7] 6,500	[8] 300
California	5,000	150	150	[9] 5,000	5,000	5,000	[8] 300
Colorado	3,750	125	125	[5] 12,480	3,750	3,120	300
Georgia	5,000	100	100	5,000	5,000	[2] 3,600	100
Idaho	[10] 4,800	[4] 1,200	200	[10] 6,400	[10] 6,400	[11] 2,400	[8] 300
Illinois	4,550	[12] 450	150	[13] 7,904	3,750	[13] 7,904	[8] 300
Indiana	5,000	100	100	5,000	5,000	[2] 9,000	[8] 300
Iowa	[2] 4,500	250	150	[10] 6,000	[2] 4,500	[8] 4,500	100
Kansas	4,000	150	150	[13] 7,488	[13] 7,488	[13] 7,488	100
Kentucky	4,000	175	75	6,000	6,000	[2] 6,000	200
Maine	4,000	200	200	6,000	6,000	5,400	100
Maryland	5,000	125	125	5,000	3,750	3,750	500
Massachusetts	10,400	[12] 250	100	4,500	4,500	4,500	[8] 200
Michigan	[2] 5,400	200	200	9,000	9,000	[14] 9,000	[8] 200
Minnesota	7,500	[12] 350	150	10,000	10,000	[2] 6,000	[8] 200
Missouri	[2] 6,250	250	150	[2] 6,000	[10] 8,000	[15] 2,000	250
Montana	[10] 6,000	125	150	[14] 7,500	[2] 6,000	[11] 2,250	500
Nebraska	[16] 5,250	150	150	[2] 4,500	[2] 4,500	[2] 4,500	[8] 200
Nevada	[3] 19,200	150	150	[5] 8,640	7,200	[17] 2,400	[8] 500
New Hampshire	3,000	100	100	[2] 4,500	[2] 4,500	[2] 4,500	[8] 100
New Jersey	[2] 6,000	250	150	[10] 8,000	[5] 6,000	[14] 10,000	100
New Mexico	[2] 9,000	225	75	[18] 6,240	[18] 6,240	[8] 18,750	150
New York	[3] 36,000	[4] 1,200	200	[5] 26,000	5,000	4,000	[8] 300
North Dakota	[3] 15,000	150	150	[3] 15,000	[8] 20,800	[8] 20,800	[8] 300
Ohio	6,500	150	150	[5] 5,850	3,750	3,750	200
Oklahoma	([19])	([19])	([19])	[14] 9,000	[2] 5,400	3,000	100
Oregon	[3] 31,200	100	100	[5] 36,400	[8] 18,200	2,400	250
Pennsylvania	7,200	150	100	6,500	6,500	[2] 4,500	100
Rhode Island	4,200	200	200	5,000	5,000	[2] 3,000	200
South Dakota	3,000	150	150	3,000	[20] 4,650	[20] 4,650	200
Tennessee	[10] 6,400	100	100	5,000	[2] 4,800	[2] 4,800	100
Texas	[21] 7,200	100	100	[22] 8,020	[22] 8,020	[2] 6,000	[8] 200
Utah	5,000	[12] 1,150	100	[5] 16,650	5,000	5,000	500
Vermont	3,500	100	100	4,000	4,000	[23] 2,600	200
Virginia	4,500	150	100	4,500	4,500	[2] 3,600	[8] 200
Washington	[3] 13,200	100	100	[5] 9,600	[5] 9,600	3,000	[8] 200
West Virginia	[3] 7,200	150	150	[5] 16,640	[24] 832	[5] 16,640	800
Wisconsin	6,000	[4] 6,600	200	[25] 19,500	[26] 6,000	[8] 19,500	[8] 200
Wyoming	3,600	150	150	8,000	8,000	1,500	300

[1] Compiled from United States Bureau of Labor Statistics, Workmen's Compensation Legislation of the United States and Canada: Bull. 423, 1926.
[2] 300 weeks.
[3] Death or remarriage, estimated 20 years.
[4] Payment to rehabilitation or special fund.
[5] Life, estimated 20 years.
[6] 100 months.
[7] 60 months.
[8] Estimated.
[9] 240 weeks.
[10] 400 weeks.
[11] 150 weeks.
[12] Payment to second-injury fund.
[13] 8 years.
[14] 500 weeks.
[15] 100 weeks.
[16] 350 weeks.
[17] 60 weeks.
[18] 520 weeks.
[19] No provision for deaths.
[20] 6 years.
[21] 360 weeks.
[22] 401 weeks.
[23] 260 weeks.
[24] 52 weeks.
[25] 1,000 weeks.
[26] 4 years.

Compensation cost of injuries by part of body affected.—The compensation cost of injuries usually varies according to the part of the body affected. The variation in cost is due largely to the ease or difficulty experienced in healing the wound, which governs the medical and hospital costs. If the injury causes the loss of a part of the body, the compensation laws of the States usually provide for the payment of compensation in an amount that is more or less related to the degree of impairment of the injured employee's ability to earn his former wages.

Because of material differences in the laws of the various States as to the compensation payable for injuries, even of similar types, and further differences as to the "waiting periods" during which no compensation whatever is paid for injuries from which the employee recovers fully, the relative amounts of compensation for injuries to different parts of the body are not comparable between one State and another. Therefore, the figures in table 4, covering 5 years of experience in the anthracite and bituminous mines of Pennsylvania, are not representative of experience in coal mining in other States but are nevertheless enlightening as to the relative costs of injuries to different parts of the body for coal mines in the largest coal-producing State. The figures in the table are from the 1929 report of the coal-mine section of the Pennsylvania Compensation Rating Bureau. The average costs are based upon a large number of cases and are therefore representative of costs of injuries to different parts of the body for coal miners in Pennsylvania.

TABLE 4.—*Average cost of accidents, by parts of body injured, for coal mines in Pennsylvania, 1925–29, converted to level of costs of accidents in 1928* [1]

Severity of injury	Average cost	Average compensation	Average medical cost
ANTHRACITE MINES			
Major permanent	$2,351	$2,155	$196
Loss of arm	3,622	3,418	204
Loss of hand	2,724	2,536	189
Loss of leg	3,685	3,375	310
Loss of foot	2,331	2,134	198
Loss of eye	2,137	2,012	125
Disfigurement	609	520	89
Other permanent	3,158	2,895	263
Indeterminate	1,945	1,700	245
Minor permanent	477	405	72
Temporary	115	71	44
BITUMINOUS-COAL MINES			
Major permanent	$2,378	$2,146	$232
Loss of arm	3,800	3,522	278
Loss of hand	2,754	2,544	210
Loss of leg	3,485	3,186	298
Loss of foot	2,525	2,245	281
Loss of eye	2,033	1,892	142
Disfigurement	2,892	2,591	301
Other permanent	1,887	1,667	220
Minor permanent	509	420	80
Temporary	115	74	40

[1] Coal-Mine Section, Pennsylvania Compensation Rating Bureau, Report for 1929.

INSURANCE COSTS

Insurance companies have found that losses in casualty insurance in mining exceed the premiums, in some cases by as much as 22 percent. For that reason many of the large insurance companies have withdrawn from taking risks in the mining industry and generally, where such insurance is granted, the insurer must give other types of insurance to the insurance company in order that the latter may try to "break even" on the compensation and attendant losses. The various States have practically been forced to offer insurance to mining companies, and apparently the rates must be high, as may be seen from the fact that in some Western States the metal-mining premium rates per $100 of pay roll in 1930 [2] were as follows: California, $10.54; Arizona, $7.79; Colorado, $5.03; Idaho, $4.15; New Mexico, $4.57; Nevada, $5.10; Utah, $6; and Washington, $3.36.

Some States recognize safety efforts and the use of safety equipment in mining operations by allowing a credit, in the form of lower insurance premiums, for the adoption of safety measures and equipment and for past safety accomplishment. In other States no such credit is allowed. It is unfair and inequitable to allow no reduction of premium to a company that spends large sums of money to prevent accidents, especially when the record of the company clearly shows that the expenditures have resulted in the elimination of accidents and, hence, a reduction in the risk covered by the insurance. In many instances, the insurance premiums charged by insurance companies or State compensation commissions have been so high that the companies, after giving safety careful consideration, have become self-insurers, thus reaping the benefit of the savings in accident costs that have resulted from the application of safety measures to their mining operations.

REDUCING ACCIDENT COSTS THROUGH SAFETY ACCOMPLISHMENT

As previously stated, the total direct and indirect costs of accidents at coal mines probably average about 20 cents a ton of coal produced. The effectiveness of a safety organization at a mine cannot be set forth readily in dollars and cents, nevertheless some fairly definite data are at hand to show what some mining companies have accomplished. A few examples will be given.

From 1930 to 1931 a coal-mining company reduced its cost of compensation, medical service, and hospitalization from 8 cents per ton of coal mined to 0.73 cent a ton for compensation alone and 1.2 cents per ton for compensation, medical services, and hospitalization. Another company, insured through a casualty insurance company, whose cost of accidents in 1927 was $40,181.63 later inaugurated a safety campaign, became self-insuring, and reduced its accident costs to $5,859.32 in 1928 and $601.16 in 1933; the total cost in 6 years, 1928 to 1933, was $237,118.60 less than it would have been if the 1927 figure had continued. A large coal company that changed from hand-loading to mechanical-loading methods lowered its accident costs from 5.5 cents a ton to 3.2 cents a ton, although a change from hand to

[2] Ash, S. H., Accident Experience and Cost of Accidents at Washington Metal Mines and Quarries: Tech. Paper 514, Bureau of Mines, 1932, 35 pp.

mechanical loading in some mines has been accompanied by an increase in the cost of accidents. James Berry, of the Ohio Department of Mines, in a statement made in 1934, is quoted as saying that prior to 1933 mine accidents in the southern section of Ohio cost 5.6 cents per ton and that, following the organization of safety work in that section of the State, the cost of accidents had been reduced to approximately 1.7 cents a ton. If the direct cost of accidents is only one-fifth of the total cost, the figures given by Berry represent a saving of five times 3.9 cents, or 19.5 cents a ton. A mechanized coal mine, with an accident cost of 11 cents a ton during the first half of 1930 and an average cost of 8 cents a ton for the entire year, lowered its costs to less than 1 cent a ton during 1932, 1933, and 1934. A large metal mine reduced its accident cost from $300,000 in 1924 to $59,000 in 1930. A group of metal mines in a State with high unit payments to the injured in case of accident lowered the cost of compensation per $100 of pay roll from $3.04 in 1926 to $2 in 1929. A bituminous-coal mine in Pennsylvania saved $60,000 or 3 cents a ton in 1 year. Through the organization of Holmes Safety Chapters and their functioning in accident-prevention work, four mines reduced their accident costs by more than half. A large coal mine in West Virginia is reported to have reduced its direct cost of accidents from 4.6 cents a ton in 1928 to 0.25 cent a ton during the first 10½ months of 1931. The estimated indirect costs for this mine were 18.6 cents per ton in 1928 and 1.3 cents per ton during the first 10½ months of 1931.

The chief factor in the reduction of industrial accidents frequently is the dual system of exercising adequate supervision and strict but just discipline; however, this is only part of the main system or organization for "putting over" safety in mining. The safety program of every mining company should by all means include a complete safety-organization plan to coordinate safety efforts; safety to be even measurably effective must start at the head of the organization, the active operating officials must be whole-heartedly behind the promotion of safety, and these officials must give a fair amount of their personal time and attention to the work to assure its success. Safety work should be under the direction of a competent safety director or engineer who should devote his entire time to safety promotion. A more or less standard organization has been developed for the mining industry, comprising a chairman, who should be the manager, superintendent, or other ranking official of the company; a secretary, who should preferably be the safety director or engineer; and a membership including all other supervisory officials of the company and representatives of each type of workmen employed. This committee should formulate safety rules, make various safety inspections and reports, and perform other functions that may be expected to lead to the improvement of health and safety in and around the mine.

This organization should be supplemented by a general safety organization (such as the Holmes Safety Association sponsored by the United States Bureau of Mines) of which all employees of the mine or quarry, including officials, surface and underground workers, and store and office force, etc., are members. Meetings should be held at least monthly. The Holmes chapter is a medium for assembling all employees in or around the mine monthly and educating them in safe practices as well as calling their attention to unsafe practices.

COST OF SAFETY WORK

It is difficult to obtain definite figures showing the cost of maintaining adequate safety in and around a mining property. Certainly, the cost of safety is not excessive, and the neglect of safety assesses a heavy cost not only on the mining company and its employees but also on the entire community.

While all officials and employees of a mine should participate actively in accident-prevention work, such work to be effective must be placed in a specific department. Since real accomplishment in safety depends largely on the safety department, the expenses of the department properly form a part of the cost of accident-prevention work in a coal mine. It should be remembered, however, that much safety work is done by the operating departments and that the cost of such work goes into the regular working accounts, however, through safety of operation efficiency is increased and costs are lowered.

Records covering eight mining companies showed that the cost of safety work ranged from one-fifth to 1 cent per ton of mineral produced. The figures are shown in table 5. One company reported a cost of 35 cents per $100 of pay roll. The variation in costs may be attributed to differences in practice as to selection of items considered chargeable to safety rather than production.

TABLE 5.—*Cost of accident-prevention work in certain mines*

Mine	Tons produced	Cost of safety work, cent per ton	Items included in cost of safety
A	220,000	1/4	First-aid training, bandages, etc., safety bonuses, safety contests, wages and expenses of safety personnel, etc.
B	7,500,000	1/3	Safety department.
C	5,200,000	[1] 35	Do.
D	300,000	9/10	Salaries, bonuses, safety meetings, first-aid contests, other small items.
E	1,200,000	3/8	Safety department.
F	(2)	3/4–1	Not available.
G	(2)	1/4	Safety-department activities.
H	725,000	1/5	Not available.

[1] Cents per $100 of pay roll.
[2] Not available.

At a conservative estimate the average cost of a well-functioning safety department is not more than 1 cent per ton of coal in coal mines, or not more than $1 per $100 of pay roll for all types of mines (coal, metal, and nonmetallic-mineral underground properties). The cost for quarries and opencut mines should be considerably less. These figures, of course, do not cover such items of accident-prevention work as apply largely to ventilation, timbering, drainage, haulage, etc., as these items are more properly chargeable against production or operating costs. The cost of safety work includes the salaries of safety inspectors; the cost of posters, first-aid equipment, etc.; the expense of training all men in first aid; and the financing of periodical safety meetings and possibly of a sectional first-aid contest annually.

There is no evidence that the energy these operating agencies devote to the promotion of safety interferes with the efficiency of production. In fact some mining companies report that safety devices, methods, and practices, put into effect by or through the operating personnel, reduce costs and increase production.

A good example of the heavy losses that follow a serious disaster is afforded by an explosion in a coal mine in Wales in September 1934 in which 265 lives were lost. Fires in the underground workings caused by the explosion made it necessary to seal the mine with its 265 dead bodies a few days after the disaster and to keep the mine sealed until March 1935. The closing of the mine threw 1,500 workers out of employment. To aid these unemployed persons and the dependents of the miners killed in the disaster a public subscription was taken, amounting to around $3,000,000. The operating company had very heavy losses due to compensation and other similar payments for the 265 deaths and additional losses due to the enormous damage done to the mine by the explosion and the loss of several months' business. Moreover, it is impossible to calculate the suffering and misery which the disaster occasioned to the relatives and friends of the dead miners, or the economic losses to the tradesmen and other members of the community due to the death of the 265 workers and the sealing of the mine for several months. It is believed that this one accident will ultimately cost between $5,000,000 and $10,000,000 in money and much more than that in misery and suffering, a sum that would amply cover the entire cost of adequate safety work in all of the coal mines of Great Britain for several years.

As already noted the total direct plus indirect cost of accidents at coal mines may reasonably be placed at 20 cents per ton of coal produced. Inquiries have been made as to the cost of preventing accidents, but definite data are difficult to obtain because too many conflicting elements enter into the cost of operating coal mines to permit an effective segregation of all those features that pertain to safety. Logically, safety involves such matters as supervision, ventilation, haulage, timbering, blasting, etc., just as much as rock-dusting, first-aid, safety organization, safety meetings, and other similar items. However, supervision, haulage, and other such items are readily recognized as essential functions of mine operation, whereas the other items are not. In many mines rock-dusting has taken its place as one of the main operating functions and is now assessed against operating cost just as are ventilation, haulage, etc. In all nonanthracite coal mines rock-dusting should be required as routine daily operating procedure.

SAFETY SAVINGS FOR EMPLOYERS AND EMPLOYEES

Examples have already been given of reduction in accident costs effected by individual mining companies that have followed well-planned safety programs. It is believed that the mining industry as a whole could, by reasonable safety effort, reduce the cost of its accidents 75 percent. In the coal-mining industry alone this would mean an aggregate saving of $50,000,000 to $60,000,000 a year, certainly a handsome "dividend" readily available whenever all companies and their employees can be induced to push safe practice in the operation of the mines. A proportionate saving could be made by all branches of the mineral industry, including metal and nonmetallic mines, quarries and stone-product plants, coke ovens, mills, smelters, and oil and gas wells and refineries. Thus the aggregate safety savings of the entire mineral industry would probably amount to considerably more than $100,000,000 a year. To make this saving the average operator would find the cost of his safety organization and program would be considerably less than 1 percent of his cost of production, or less than 1 cent a ton in coal mining and less than $1 per $100 of pay roll in other types of mining.

The benefits of accident-prevention work to the employee are greater and more vital than to the employer. No estimate ever can be made of the enormous amount of human suffering and misery involved in the 2,000, to 3,000 fatalities and 100,000 to 150,000 nonfatal accidents that have occurred annually in and around our mining operations. Only rough approximations can be made as to the dollars-and-cents cost of these accidents to the workers and their dependents. As the average age of men killed in industrial accidents is about 35 years, the life expectancy that is destroyed when a miner is killed has been generally placed at 20 years. In that period the miner would have earned approximately $20,000 for his services. It has been indicated in this paper that about 25,500 lives have been saved in the mineral industry during the past 24 years. The saving of these lives means the prevention of a financial loss to the mine workers and their families of around $510,000,000. During the same 24-year period it is estimated that approximately 1,275,000 nonfatal accidents have been prevented and that a total of about $765,000,000 has been saved to the employees in loss of wages and other costs which would not have been covered by compensation payments for injuries. To these figures must be added the prevention of millions of noncompensable nonfatal injuries during the past 24 years, for which the financial burden falls more heavily on the injured person than on the employer. These facts make it certain that our mine workers have benefited to the extent of at least $200,000,000 annually by the greater safety in mining operations during the past 24 years.

IMPORTANCE OF RECOGNIZING ECONOMIC FEATURES OF SAFETY MEASURES

Instead of safety effort or safety "preachments" being the "fad" which many of those engaged in mining have considered it, the prevention of accidents now is becoming known as one of the most vital economic features in the production of our mineral commodities. There is good reason to believe that there are few if any phases of mining that have greater possibilities for relatively quick and effective decrease of production costs and increase of working efficiency than have the installation and strict maintenance of an up-to-date safety procedure in and around mines and quarries.

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